PLATE I

Salicin. Orthorhombic crystals from alcoholic solution.

Cocaine hydrochloride Aggregates from aqueous solution.

CRYSTALS IN POLARIZED LIGHT (Crossed nicols).

PHARMACOGNOSY

BY

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Second Edition, Thoroughly Revised

With 372 Illustrations and 3 Colored Plates

LEA & FEBIGER
PHILADELPHIA

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PREFACE TO SECOND EDITION

In preparing the second edition the authors have attempted to bring the text up to date. Several new items have been added and at the same time, that part of the text concerning the more obsolete items has been considerably shortened. In many instances descriptive matter that can readily be found in the U. S. Pharmacopœia or the National Formulary has been deleted The arrangement according to the taxonomy of the plants yielding the drugs has been retained, although there is some question as to whether or not it is the preferable arrangement. For teachers who prefer to stress the chemistry of the drugs, a section has been added to the Introduction and the discussions of the individual chemical groupings have been considerably enlarged. Special general sections on drug plant cultivation, preparation and storage, the commerce of drugs and the analysis of drugs have also been added.

Emphasis on the immediate official status of the individual drugs has been removed, and in its place is given the complete official history of the drug. Thus, at the beginning of each monograph will be found the actual period during which the drug was official in the Pharmacopœia or the National Formulary. A tabulation of the official history of the classes of drugs, especially those consisting of plant parts, chemicals of different classes and pharmaceutical preparations is included in the first section of the book.

As was the case in the first edition, the authors have attempted to present the information in such a manner as to be useful for text book study, and still retain its value as a reference work

The authors wish to gratefully acknowledge the following assistance and contributions to the revision· To Dr Ralph F. Voigt, Assistant Professor of Pharmacognosy and Assistant Director of the University of Illinois, Drug Plant Experiment Station, who prepared the sections on Drug Plant Cultivation, and contributed to the section on the production of drugs; to Dr. Esther Meyer, Assistant Professor of Bacteriology in the University of Illinois, College of Medicine, who prepared the section on Bacteriologics and Antibiotics, to Dr. Ernst R. Kirch, Assistant Professor of Chemistry in the University of Illinois, College of Pharmacy, who prepared the section on Vitamins, to Dr.

Frank T. Maher, Assistant Professor of Pharmacology in the University of Illinois, College of Pharmacy, who prepared the section on Endocrines and Hormones; to Professor Paul D. Carpenter, Assistant Professor of Zoology and Botany in the University of Illinois, College of Pharmacy, who contributed line drawings and photographs; and to Dr. Edward P. Claus, formerly Assistant Professor of Botany and Pharmacognosy, in the University of Illinois, College of Pharmacy, who prepared the section on Allergens.

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PREFACE TO FIRST EDITION

The authors have undertaken the preparation of a new text in pharmacognosy based on the third edition of Kraemer's Pharmacognosy. This new text particularly presents the recent researches on the chemistry of drugs, and therefore it supplies a balanced pharmacognosy text and one conforming to the most modern ideas in this science; it also conforms to the standards of the eleventh revision of the U. S. Pharmacopœia and the sixth edition of the National Formulary.

The progress of pharmacognostical research in Europe during the past several decades is especially noteworthy as regards the isolation of the chemical constituents of drugs as well as their identification by microchemical means. Dragendorff in plant chemistry and Behrens in microchemistry were notable European workers of an earlier generation. These men have been followed by Tunmann, Rosenthaler, Molisch and others in the microchemical study of plants and of drugs. Tschirch in his "Handbuch" definitely follows a chemical classification. Driver and Trease have published their "Chemistry of Crude Drugs." However, no American pharmacognocist has thus far presented the chemistry of drugs as a leading part of a pharmacognostical text.

The junior author of this text has acquired, during his studies in Europe, the viewpoint of European pharmacognocists. Therefore this text will reflect his studies on the chemical side of pharmacognosy. This is in accord with the ideas of Dr. Henry Kraemer, who emphasized the need of a knowledge of the chemical constituents of drugs. Note the following quotations from the preface to the second edition of Kraemer's Pharmacognosy: "The study of plant constituents is receiving greater attention and the papers dealing with the microscopical studies are increasing in number. The examination of sublimates obtained upon pyro-analysis of drugs is deserving of greater attention. During the past few years the author has had many students follow this kind of work with a great deal of success. The knowledge of active principles which can be sublimed is increasing and one is almost constrained to say that there are very few drugs which do not yield a characteristic sublimate on igniting the drug. Furthermore, these sublimates can be further tested for identity so that in applying this form of analysis it has a specific value in identifying the drug and may be used as a criterion of its quality. For these reasons this subject has been enlarged upon and new illustrations have been introduced."

In addition to the broader presentation of the chemical ingredients of drugs and their microchemistry, there have been introduced in this new text many new monographs describing official chemical substances

obtained from crude drugs; however, these new monographs usually have not been so fully developed as are the monographs of the crude drugs.

Several monographs on crude drugs that have been recently introduced into medicine are included in the text; likewise many new statements bearing on recent investigations of some of the older crude drugs are introduced into the respective monographs.

The illustrations in Kraemer's Pharmacognosy, Third Edition, were remarkably fine and abundant, yet it has been possible to add to these quite a number of illustrations presenting more recent information or a more accurate picture. Particular acknowledgment is due to Raymond S. Adamson, Gerston Bruch and Paul D. Carpenter, for line drawings and photomicrographs. In each case the name of the artist is included in the legend.

The chapter on animal drugs, as published in Kraemer, has been largely rewritten and many new official and unofficial items have been introduced. *Especial acknowledgment is due to Dr. Paul Mattis for* certain illustrations in the section of this chapter bearing on desiccated glandular products used in medicine.

The use of smaller type for certain portions in the monographs of official drugs and for the entire monographs of unofficial drugs, improves the appearance of the text without impairing its readability, and makes the leading portions of the text stand out more vividly. The portions containing detailed or highly technical descriptions and the text of the unofficial drugs are less prominent because these are of less general interest. Thus we have been able to retain a description or mention of nearly every drug item found in Kraemer's Pharmacognosy, yet also to add many new items without increase in the size of the book.

Particular acknowledgment and thanks are due to Mrs. Minnie Kraemer Harris of Baltimore for permission to use not only parts of the text but also some of the illustrations of Kraemer's Pharmacognosy, Third Edition.

E. N. G.
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CHICAGO, ILL.

CONTENTS

PHARMACOGNOSY

GENERAL CONSIDERATIONS

THE DEFINITION OF PHARMACOGNOSY

The term **pharmacognosy** was introduced by Seydler in 1815, and is formed from two Greek words, *pharmakon*, drug, and *gnosis*, knowledge, and literally means the "entire knowledge of drugs." The most comprehensive idea of the scope of pharmacognosy has been given to us by Fluckiger, who states that it "is the simultaneous application of various scientific disciplines with the object of acquiring the knowledge of drugs from every point of view."

Pharmacognosy may be defined as the study of drugs having their origin in the plant or animal kingdom. In the broad sense this includes a knowledge of the history, distribution, cultivation, collection, selection, preparation, commerce, identification, evaluation, preservation and use of drugs or economic substances bearing on the health of man or other animals. In a restricted sense, the definition implies a particular knowledge of methods of identification and evaluation of drugs. The study of drugs from the standpoint of their medicinal action or value gradually has become separated from the study of their other characteristics and is known as **pharmacology**.

THE HISTORY OF PHARMACOGNOSY

Tschirch has well said that pharmacognosy dates back further than any of the departments of pharmacy. He rightly states that the old herbalists (rhizotomists) were really the first pharmacognocists, and he considers that Dioscorides, by reason of his writings on medicinal plants, was the first teacher in pharmacognosy

Pharmacognosy was unusually well expounded by Martius, who, in 1825, published a work entitled "Grundriss der Pharmakognosie des Pflanzenreiches," and may be regarded as a great pioneer in modern pharmacognosy

Prior to the time of Martius and even later, it was customary for the users of drugs to collect them directly from the living plants and it was necessary for them to properly identify these medicinal plants in the field. The work of the herbalists and systematists of earlier times gradually merges with that of the morphologists of recent years.

Modern pharmacognosy developed from Schleiden, who announced in 1838 that the cell is the fundamental unit in plants and showed that

the different tissues are combinations of similar cells. About this time also, herbaceous drugs as such, became quite important in commerce and the necessity of distinguishing and evaluating them developed. Many drugs resemble each other rather closely when viewed macroscopically, but microscopically marked differences in cellular characteristics may be apparent. For instance, Schleiden, who had no knowledge that the several commercial sarsaparillas were obtained from different species of *Smilax*, showed by reason of certain differences in the cells of the hypodermis and endodermis that they must be obtained from different species, which later was proven to be the case.

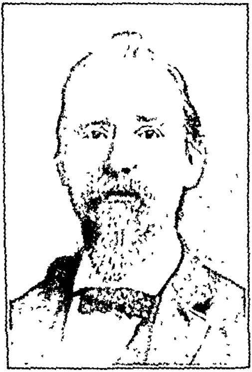

FIG 1.—John M. Maisch. 1831–1893.

FIG. 2—Henry Kraemer. 1864–1921.

The histology of plants and animals, hence of drugs, has been highly developed since Schleiden's time and now constitutes one of the basic sciences in applied pharmacognosy.

Among the botanists who have had an important part in the development of histological pharmacognosy, which makes the pharmacognosy of today such an exact profession, are O. H. Berg, E. Gilg, H. Molisch, O. E. Oesterle and J. Moeller of Germany; A. Meyer of Austria; A. Tschirch of Switzerland; F. G. Planchon, E. Collin and E. Perrot of France; D. Hanbury, E. M. Holmes and H. G. Greenish of England; J. M. Maisch, H. H. Rusby and H. Kraemer of America.

With the discovery of alkaloids as active principles in drugs by Derosne, Sertüner and Pelletier (1803–1825), the foundations of chemical pharmacognosy were laid. Here again during the past hundred years,

a great fund of knowledge regarding the chemistry of plants and animals, hence of drugs, has been accumulated. However, it must be said that this information is as yet not nearly so complete as is the histological knowledge. Among the chemists who have played an important part in pharmacognosy are H. E. Merck, H. F. M. Thoms and O. Tunmann of Germany; F. A. Flückiger and A. Tschirch of Switzerland; J. G. M. Dragendorff of Russia, J. O. Schlotterbeck and F. B. Power of America.

The "Pharmacographia" of Flückiger and Hanbury and the "Handbuch" of Tschirch are outstanding works on the history of drugs; the "Pflanzenmikrochemie" of Tunmann laid the foundation for our present microchemistry of drugs, and the "Materia Medica" of Pareira is an early monument in medical pharmacognosy.

Among the noted pharmacognocists of today are G. E. Trease and T. E. Wallis in England; O. Moritz, R Fischer and G. Karsten in Germany, H. W. Youngken, A. Viehoefer and E. L. Newcomb in America. Among the microchemists are A. Mayrhofer of Germany; L. Rosenthaler of Switzerland, and M. Wagenaar of Holland. A list of well-known books on pharmacognosy is appended.

N. L. Allport: "The Chemistry and Pharmacy of Vegetable Drugs" (1944.)
E. Collin. "Traite de toxocologie vegetale" (1904)
Cooper, Denston and Riley: "A Text Book of Pharmacognosy" (1931).
T. C. Denston: "A Textbook of Pharmacognosy" (1939)
J. E. Driver and G. E Trease "The Chemistry of Crude Drugs" (1928).
I. R. Fahey: "Pharmacognosy" (1932).
Robert Fischer: "Praktikum der Pharmakognosie," (1942)
F. A. Fluckiger and D. Hanbury "Pharmacographia" (1879).
Gilg, Brandt and Schürhoff: "Pharmakognosie" (1927).
E. Gilg: "Grundzuge der Botanik fur Pharmazeuten" (1921).
O. Giswold and C H. Rogers "The Chemistry of Plant Constituents" (1943).
C. B. Gnadinger "Pyrethrum Flowers" (1936).
H. G. Greenish: "A Text Book of Materia Medica" (1924)
H. G. Greenish and E Collin "An Anatomical Atlas of Vegetable Powders" (1904).
H. G. Greenish: "The Microscopical Examination of Foods and Drugs" (3d ed) (1927).
R. Jaretzky. "Lehrbuch der Pharmakognosie" (1937)
G Karsten and W Benecke: "Lehrbuch der Pharmakognosie" (1928).
H. Kraemer "Scientific and Applied Pharmacognosy" (3d ed) (1928).
J. M Maisch: "A Manual of Organic Materia Medica" (1890).
W. Mansfield "Histology of Medicinal Plants" (1916)
A. Mayrhofer "Mikrochemie der Arzneimittel und Gifte" (1923-1928).
J. Moeller and C. Griebel "Mikroskopie der Nahrungs- und Genuszmittel aus dem Pflanzenreiche" (1928).
J. Moeller "Pharmakognostischer Atlas" (1892)
H Molisch "Mikrochemie der Pflanze" (1923).
Otto Moritz: "Einfuhrung in die Allgemeine Pharmakognosie" (1936).
L. E. Sayre "Organic Materia Medica and Pharmacognosy" (4th ed) (1917).
A. Schneider: "Microanalysis of Powdered Vegetable Drugs" (1921).
O. Tunmann and L Rosenthaler. "Pflanzenmikrochemie" (1931).
G E. Trease "A Textbook of Pharmacognosy" (1945).
A Tschirch: "Handbuch der Pharmakognosie" (1932).
A. Tschirch and O. E Oesterle: "Anatomischer Atlas" (1900).
A. E. Vogl "Anatomischer Atlas zur Pharmacognosie" (1887).
A. Vrgoc: "Uputa u Farmakognoziju."

O. A. WALL: "Han
T. E. WALLIS: "A
T. E. WALLIS: "Pr
T. E. WALLIS: "T
H. C. WASHBURN a. and Materia Medica" (1927).
R. WASICKY and co-workers: "Leitfaden fur die pharmakognostichen Untersuchungen im Unterricht und in der Praxis" (1936).
A. L. WINTON and K. B. WINTON: "The Structure and Composition of Foods" (1932).
H. W. YOUNGKEN. "Textbook of Pharmacognosy" (1943).

THE STUDY OF DRUGS

The **natural origin** of a drug is the plant or animal yielding it; if a plant, **botanical origin** or **botanical source** and if an animal, **zoölogical origin** or **zoölogical source**. It is essential therefore that the pharmacognocist have a sound background in **biology**. The scientific **name** and **classification** of the plant or animal yielding the drug, as well as a knowledge of its **morphology** and **histology** are necessary for the **identification** of the drug, hence **zoology** and **botany** are essential to the pharmacognocist A knowledge of the production of the drug, including its **geographical source**, and of **drug plant cultivation**, a feature of increasing importance in pharmacognosy, requires a basic knowledge of **world geography, global economics, horticulture, plant physiology** and **entomology**, as well as **plant ecology** and **plant genetics**. **Drug identification** and **evaluation** requires a working knowledge of **plant chemistry, physics** and **crystallography**. Some knowledge of **Latin** is useful in understanding the derivation of scientific names and a reading knowledge of foreign languages, especially **German** and **French** in botany and chemistry, and **Russian** and **Swedish** in horticulture are invaluable in reading original publications.

On the other hand, no amount of reading or scientific training will fully take the place of a real interest in the subject. This can be acquired in the drug store or drug warehouse, in the field or in the college laboratories with their extensive collections.

The Study of Drugs may be pursued from a number of viewpoints. In an artificial system, they may be grouped according to the **parts of plants** which constitute the drug, as roots, rhizomes, leaves, etc. This method has much to commend it in practice, but unfortunately the form of the commercial article is not such that it is always possible to determine whether it should be placed among roots or rhizomes, leaves or herbs, etc. A second system of arranging drugs is according to their important **constituents**. Since the action of drugs is dependent upon these constituents such a chemical classification would seem to be the most rational As our knowledge of the chemistry of drugs increases there is no doubt that it will become the accepted means of classification. Unfortunately, however, our knowledge of the chemical constituents of drugs is still often meager, and even in those drugs that have been investigated there may be present a number of principles,

each of which serves a useful purpose. A third method is to consider the plants yielding drugs according to their **natural relationship.** With our knowledge of morphology, including both organography and the internal structure of a large number of plants, it would seem that this still furnishes the best system for practical pharmacognosy. In a large number of families we find there are certain morphological characters that are more or less distinctive for each: the *Compositæ* contain inulin; the *Labiatæ* have square stems and bilabiate calyxes and corollas, as well as a typical 8-celled glandular hair and usually contain volatile oils; the *Solanaceæ* are abundant in mydriatic alkaloids, the *Umbelliferæ* yield volatile oils, and so on. Furthermore two or more drugs are not infrequently derived from a single plant, and for this reason can be better considered in connection with the products derived from a single plant than if they are placed in widely divergent groups.

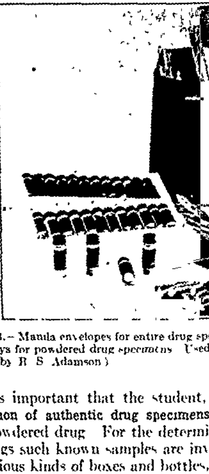

FIG. 3.—Manila envelopes for entire drug specimens and screw-cap vials in a box with four trays for powdered drug specimens. Used by students at the University of Illinois. (Photo by R. S. Adamson.)

It is important that the student, pharmacist or analyst possess a **collection of authentic drug specimens** both of the entire drug and of the powdered drug. For the determination of the identity and purity of drugs such known samples are invaluable. Specimens may be kept in various kinds of boxes and bottles, or in manila clasp envelopes; the latter utilize a minimum of space, may be filed, and provide abundant space for names and notes on the drug enclosed in them. Another satisfactory way is to keep the drugs in type cases, such as are used by printers, the top being covered with glass which can be removed. This method gives at one time a view of all of the drugs in the case.

The powdered drugs may be conveniently kept in vials in suitable light-proof containers. Where insect attack is likely to occur a few crystals of p-dichlorobenzene added from time to time will keep specimens in good condition.

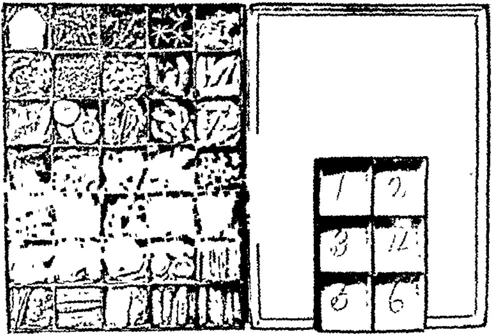

FIG. 4.—Pharmacognosy specimen case constructed of cardboard, covered with black paper muslin and with hinged glass cover, as used by students at the University of Minnesota. The six compartment box is used in presenting specimens to students. (Photo by Newcomb.)

An organized record of the facts regarding each drug studied should be kept by the student; hence a note book, including drawing paper, should be provided. The employment of sketches to record macro- and micromorphological features of drugs cannot be too strongly recommended. Such sketches often illustrate features which would require hundreds of words to describe. Furthermore an outline form suitable for systematizing the notes is highly desirable. Such a form commonly used in the laboratory study of drugs, is as follows:

OFFICIAL TITLE

1. Latin Title and Synonyms.
2. Definition.
3. Geographical Source (see map of ———).
4. Shape and Size.
5. External Markings and Color.
6. Fracture and Internal Color.
7. Odor and Taste.
8. Structure.
9. Constituents and Standards of Quality.
10. Tests for Identity and Purity and Common Adulterants.
11. Therapeutic Properties and Use
12. Dose.

THE PRODUCTION OF DRUGS

The Federal Food, Drug and Cosmetic Act defines a drug as follows:

> "The term 'drug' means (1) articles recognized in the official United States Pharmacopœia, official Homeopathic Pharmacopœia of the United States, or official National Formulary, or any supplement to any of them; and (2) articles intended for use in the diagnosis, cure, mitigation, treatment or prevention of disease in man or other animals, and (3) articles (other than food) intended to affect the structure or any function of the body of man or other animals; and (4) articles intended for use as a component of any articles specified in clause (1), (2) or (3); but does not include devices or their components, parts or accessories"

A vegetable or animal drug is then an article of vegetable or animal origin conforming to the above definition It may be an actual therapeutic agent, it may be a surgical or anesthetic aid or it may be a pharmaceutical necessity, that is a solvent, a vehicle, a sweetening, preserving, flavoring, or coloring agent, or it may be a diagnostic aid. Vegetable or animal drugs which consist of plant or animal parts that have undergone no other processes than collection and drying are sometimes designated as **crude drugs**. They may themselves be used as therapeutic agents or they may, upon further treatment yield products that are used for drug purposes. Any discussion of vegetable or animal drugs must of needs begin with the plant or animal yielding them.

Many plants and animals that produce drugs also produce foods, spices and condiments, narcotics, textiles, lumber, tanning extracts, perfume oils, ornamental flowers and a host of other economic products. The production of such food and economic products often parallels in many ways the production of drugs.

The **geographical source** and **habitat** is the region in which the plant or animal yielding the drug grows. Sometimes this term is applied erroneously to the drugs themselves Drugs are collected in all parts of the world, though the tropics and subtropics yield more drugs than do the arctic and subarctic regions. The Mediterranean Basin including Asia Minor yields more drugs than any other region of the world. However, India, the East Indies, central Europe, northern South America, Mexico and Central America, North America and other regions yield numerous and valuable drugs.

Neither the scientific name of the plant nor the commercial name of the drug may be relied upon as indicating the true habitat of drug plants. For example, the specific name of *Spigelia marilandica* indicates that the plant is found in great abundance in Maryland, whereas it is only occasionally met with in that state. In other cases plants are common to a much larger territory than the specific name would indicate, as *Prunus virginiana*. Peru balsam, for example, does not come from Peru but is produced in San Salvador, while most of the Spanish licorice now comes from Asia Minor.

Plants growing in their native countries are said to be **indigenous** to

those regions, as *Stillingia sylvatica*, of the southern United States; *Aconitum napellus* of the mountainous regions of Europe, etc. Plants are said to be **naturalized** when they grow in a foreign land or in a locality other than their native home. Some of these may have been introduced with the seeds of cultivated plants, some by birds or ocean currents, others by ballast of ships, and so on.

Drugs may be collected from wild plants, or plants may be cultivated for the production of drugs.

Cultivated medicinal plants have been propagated in China, India, Europe and many other lands for centuries past. In Europe, the medicinal plant gardens of the monasteries date back to rather early in the Christian era. With the advent of colonizing, beginning shortly after the discovery of America and continuing almost to the present, many countries made definite attempts to cultivate drug and economic plants in their possessions. Thus vanilla, a native of Mexico and Central America, is now produced at such distances from its original habitat as the Island of Reunion, Tahiti and Mauritius. Cocoa, another native of Mexico, is now produced in large quantities in Nigeria and the African Gold Coast, in Ceylon and in Java. Cinchona, native to the South American Andes, was developed as a crop in Java. By 1900 the South American production was practically nil, due to the destruction of wild trees and the Dutch had a world monopoly on cinchona and its alkaloids. Quite a similar situation exists with coca, another South American plant transported to Java.

In many instances plants have been cultivated in their native habitats, either because of dwindling natural supply, or to improve the quality of the drug. Before World War II the Japanese had established large plantations of camphor trees in Formosa, and held a virtual monopoly in natural camphor. Ceylon cinnamon is entirely produced from cultivated plants, which is also true of cardamom and opium.

Certain areas in the United States are devoted to extensive cultivation of certain drug plants. Areas in southern Michigan and northern Indiana are devoted to the culture of mints, and a large part of our supply of peppermint and spearmint oils come from this region. Carroll County, Maryland, produces a large part of our supply of chenopodium oil. A small area in Washington produces almost our entire supply of hydrastis. Louisiana produces castor oil from cultivated plants. In recent years the State of California has sponsored drug and oil plant cultivation among the farmers in the southern part of the State, and this area produces several million dollars worth of drug and economic products annually, all from cultivated plants.

In addition to the economic reasons there are many other advantages in the cultivation of drugs; definite species and varieties can be controlled; the treatment after collection can be controlled and attack by insects and fungi can be prevented; all resulting in an improved product In many instances improvements in drugs, especially in their content of active constituents can be produced by breeding and soil studies. Several experiment stations have been established for this type of research as well as for graduate instruction in drug

Washington and Ohio State

The cultivation of drug plants is often intricate and involves many problems, the solution of which depends upon specific conditions. A general outline of the principles involved in drug plant cultivation is therefore presented as a separate section on page 55.

Collection of drugs from cultivated plants always insures a true natural source. This may, or may not, be the case when drugs are collected from wild plants. Carelessness or ignorance on the part of the collector may often lead to complete or partial substitution This is especially true when drugs are difficult to collect or the natural source is very scarce. Many drugs are collected from *wild plants*, sometimes on a fairly extensive scale (tragacanth, senna) where collection is the vocation of the gatherer, and sometimes on a limited scale where collection is an avocation (podophyllum, slippery elm).

spigelia, podophyllum, serpentaria, and many other native American drugs

tain states of Montana, Wyoming and Colorado

The proper time of harvesting or collection is during that period when the plant part constituting the drug is highest in its content of active principles and when the material will dry to give the maximum quality and appearance The following general rules for the collection of various drugs may be given

1. Roots, rhizomes and barks should be collected in the fall after the vegetative processes have ceased. In rare cases they may be collected in the spring before these processes begin. Roots, especially if they are fleshy, will shrink and remain spongy after drying if collected during the growing season (burdock, marshmallow root, belladonna root)

2. Leaves, or leaves and flowering tops should be collected when photosynthesis is most active, which is usually about the time of flowering and before the maturing of the fruit and seed (belladonna leaf, sage).

3. Flowers should be collected prior to or just about the time of pollination (arnica, marigold).

4. Fruits should be collected near the ripening period, *i e*, when full grown but unripe (cubeb, black pepper).

5. Seeds should be collected when fully matured, that is when most of them have ripened, but if possible before the fruits have opened (black mustard).

The influence which the *time of collection* has on the quality of vegetable

when the

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will yield over 3 per cent of santonin, but just as soon as the flowers mature there is a rapid disappearance of the anthelmintic principle. Dealers in insect powder (pyrethrum flowers) know that the flowers gathered when they are closed produce the finest and most powerful insect powder, worth nearly twice as much as that made from the half-closed or open flowers.

The **mode of harvesting** varies with the drug being produced and with the pharmaceutical requirements of the drug The casual, unskilled native usually collects the drug by hand, and sometimes is careless as regards admixtures and

adulterations. When the cost of labor is an important factor, the use of mechanical devices is often successful in economically producing the drug. With some drugs, however, where the skilled selection of plant parts is an important factor, mechanical means cannot replace hand labor (digitalis, tobacco). Most overground parts of plants have been collected by hand in the past. Where speed and reduced cost of production are required they can often be collected by means of mechanical devices such as pickers, mowers, binders and combines. Plant material for distillation (peppermint, spearmint) is cut with a mower and left in the swath to partially dry, then raked together and hauled to the stills. For leaves and herbs the cut plants may be hauled directly to the dryers and after drying, the leaf material may be separated from the stems.

At the appropriate time, crops producing fruits and seeds are best cut with a combination mower and binder; the bundles are placed in shocks and after the desired parts are fully cured, ripened and dried, the fruits and seeds are readily separated by threshing (caraway, flaxseed). Flowers are best collected by the use of a hand cranberry scoop or seed stripper. This is a large "comb" with its teeth far enough apart for the stems to enter but close enough to snap off the flowers. This principle is adopted in the mechanical rotary flower picker, in which the teeth are affixed to a rotating drum (pyrethrum flowers, clover).

Barks are largely removed by hand stripping. When it is not necessary to produce large pieces of bark, it may be separated from the wood by sand blasting, and then separating the bark pulp from the sand by means of flotation in water or by air currents. Where roots or other underground parts of the plant constitute the drug, they may be dug by hand, or such mechanical devices as the plow, the potato digger or the shrubbery-lifter may be utilized. The plow and potato digger are adaptable to shallow rooted plants while the shrubbery-lifter is used for deeply rooted ones. In order to comply with the Pharmacopœia and National Formulary limits on acid-insoluble ash, adhering dirt and sand, etc., all of the soil must be removed from the roots. This is best removed by immediately placing the freshly dug roots in special root washing machines.

Drying the plant material removes sufficient moisture to insure good keeping qualities, prevents molding, the action of enzymes, the action of bacteria and
It fixes the constituents and facilitates
the drug into a more convenient form
successful drying involves two main
principles: temperature control and regulation of air flow. Control of the
ature of the material to be dried and the
luct. The plant material can be either
Air drying may be done in the sun or
in the shade depending upon the material. Sun drying is adaptable to those
Shade

ıen
ıay
be either purchased or designed and built. In principle it consists of a closed space spanned by several to many movable screen trays which are arranged to allow free circu
source of heat wh
be of such a size
anticipated load
ture for vaporizing the moisture but not high enough to affect the constituents of the drug and the ventilation such as to efficiently utilize the heat units in the air and then remove the moisture-laden air at the time of saturation. When heat and ventilation are properly controlled the plant material is thoroughly

t
d
moisture content of the leaf is sufficient to cause an enzymatic hydrolysis of

the cardiac glycosides as soon as the leaf is harvested. If the leaves are allowed to dry naturally a very rapid hy

Leaves and overground plant trays and are dried at moderate temp viding the active principles are not destroyed by these elevated temperatures. Drugs containing volatile constituents are usually air dried or dried in mechanical dryers at a temperature low enough to prevent loss of their volatile principles. Frequent stirring exposes the material to an exchange of air and hastens drying The proper point of dryness can usually be determined by the brittleness and snap of the plant parts.

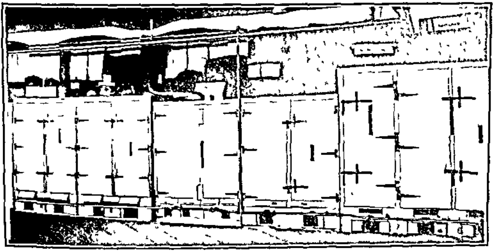

FIG. 5 —Battery of gas-heated drying ovens for the rapid drying of digitalis, belladonna, hyoscyamus and other drugs not injured by moderate temperatures Drug Drying Laboratory, University of Minnesota.

Roots and rhizomes after being thoroughly washed are carefully and thoroughly dried. Large and fleshy roots such as veratrum viride, belladonna root ng Where climatic rocess requires from ied to insure proper with artificial heat, rapidly and form a yness may again be

Barks are dried either in the sun or shade or by means of artificial heat, depending largely on the constituents The alkaloids of cinchona bark for example, decompose in the presence of moisture, and drying with artificial heat is necessary to insure a drug of high quality.

Flowers require greater care in drying than other plant parts because their active principles are likely to be less thermostable than those of other drugs They are usually air dried or at a very low heat in mechanical dryers where proper air circulation can be maintained. Fruits and seeds are generally dry before harvesting and especially before threshing. If not thoroughly dry they may be spread o

With some dru ing are necessary require special drying processes.

Garbling is the final step ing of extraneous matter, adulterants. This is done

after the drug is dried and before it is baled or packaged. Unfortunately it is often not done until the drug has entered commerce when it involves a depreciation in the market value of the lot. It often becomes necessary to garble drugs to enable them to pass legal requirements In leaf drugs an excess of stems (buchu, senna, uva ursi) must be removed; in rhizomes and tubers, overground stems or stem bases may be excessive (aconite); and in some cases the proportion of roots to rhizomes may be too large. In cypripedium and hydrastis, the roots ("fiber") contain less active constituent, and should be present only in the natural proportion. In some cases particles of iron must be removed with magnets before the drug is ground. Dirt and sand can often be removed by sifting or by means of currents of air In such cases where the powdered drug may ...) dies and punches is ver ... cases be done by mech

The **packaging** of drugs is dependent upon their final disposition. If, as is usually the case, this is transportation, storage and ultimate use for manufacturing purposes, it is customary to choose that type of packaging that will provide ample protection to the drug as well as an economy of space. Leaf or herb material is usually baled with power balers into a solid compact mass, which is then sewn into a burlap cover. For overseas shipment such bales weigh from 500 to 800 pounds Seeds and fruits as well as rhizomes and roots are usually packed in burlap bags and weigh from 100 to 200 pounds. Wooden or corrugated paper boxes and barrels are also common shipping and storage containers. Drugs likely to deteriorate from absorbed moisture (digitalis, ergot) are packed in moisture proof cans Gums, resins and extracts are shipped in barrels, boxes or casks and vanilla beans in lead or tin lined boxes.

Proper **storage** and **preservation** are important factors in maintaining a high degree of quality of the drug Warehouses should preferably be of fireproof, steel, concrete or brick construction, they should be unheated and rodent proof. Hard packed bales usually reabsorb little moisture; this is also true of barks and resinous drugs, but leaf, herb and root drugs, not well packed tend to absorb moisture up to 10 per cent, 15 per cent or even 30 per cent, of the weight of the drug Excessive moisture not only increases the weight of the drug, thus reducing the percentage of active constituents, but also favors enzymatic activity, and facilitates fungal growth The glycosides in digitalis tend to deteriorate when moisture in the drug reaches 8 per cent or higher. Ergot, gambir, opium, gentian, taraxacum, veratrum viride, aconite, ginger, etc, sometimes occur in a moldy condition Light adversely affects drugs which are highly colored, rendering them unattractive and possibly producing undesirable changes in constituents. It has been shown that polarized light produces changes more rapidly than ordinary light, and since reflected light is always polarized to some extent, sunlight reflected onto drugs will bring about deterioration. The oxygen of the air increases oxidation of the constituents of drugs, especially when oxidases (oxidizing enzymes) are present. It is therefore very desirable that the warehouse be cool, dark and well ventilated with dry air.

The preservation of ... rlooked. The insects which inf ... *idoptera, Coleoptera* and *Diptera* ... include the cornmeal moth (*Tinea zea*) which during its larval stage is known to attack aconite, capsicum, ergot, lappa, linseed, rhubarb, taraxacum and many other drugs Among the *Coleoptera* are various members of the *Ptinedæ*, as *Ptinus brunneus, Anobium paniceum* and *Lasioderma serricorne*, which attack the spices chiefly, as capsicum, cinnamon and pimenta. Chief among the *Diptera* is *Trypeta arnicivora*, which is sometimes found in the receptacles of arnica flowers For the destruction of these insects and the prevention of their attacks a number of substances and methods have been employed, the simplest method of all being to expose the drug to a temperature of 65° C. This method is probably the most efficient in not only preventing insect attacks, but all other

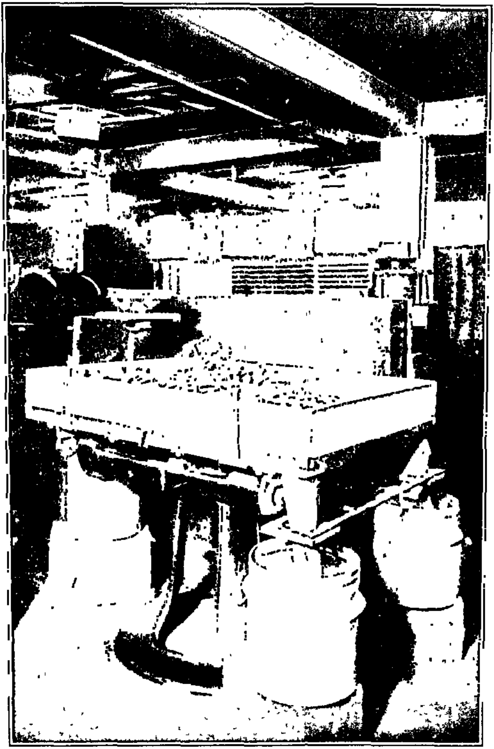

FIG. 6.—Gyrator sifter with screen top used for the cleaning of gentian, licorice and similar root drugs, also used with finer screen for the removal of dust and fine sand from digitalis and other leaf drugs. Drug Milling Laboratory, University of Minnesota

forms of deterioration. For the fumigation of large lots of crude drugs such as are met with in warehouses and manufacturing plants, the use of methyl bromide

er and nutmeg) insect

's of either sprinkling

slaked lime. In these

ered an adulterant.

Small lots of drugs may readily be stored in air-tight, moisture-proof and light-proof containers. Tinned cans, covered metal bins or amber glass containers are the most satisfactory. Drugs should not be stored in wooden boxes or in drawers and especially not in paper bags. Not only is deterioration hastened, but odors are communicated from one to another, and attacks by insects are facilitated and destruction by mice and rats may occur. Insect attack can be controlled by the addition of a few drops of chloroform or carbon tetrachloride from time to time, provided the container is air tight. In cases such as digitalis and ergot, where a low moisture content must be maintained at all times, the insertion of a suitable cartridge or device containing a non-liquefying, inert, dehydrating substance, may be introduced into the container, which should be air-tight and moisture-proof.

Since high temperatures accelerate all chemical reactions including those involved in deterioration, drugs must always be stored at as low a temperature as possible An ideal temperature would be just above freezing, but since this is impractical in most cases, the warehouse or other storage place should be as cool as possible. Certain drugs such as the biologicals, must be stored at a temperature not exceeding 5° C

Animal Drugs are produced from wild or domesticated animals; if from wild animals they must be hunted (whale, musk deer) or fished for (cod and halibut), and so in a sense parallel the collection of vegetable drugs. Many animal drugs however are produced from domesticated animals, and so in a sense parallel the cultivated vegetable drugs. Where drugs consist of insects (cantharides, cochineal) they are collected from wild insects or definite attempts may be made to cultivate them, *i. e*, to furnish them food and shelter and to maintain optimum conditions for their propagation (honey bee, silkworm). Drugs such as lard, lanolin, milk and milk products, as well as the hormones, the endocrine

peutic agents and pharmaceuticals The processing and purification of the animal drugs vary with the individual drug.

COMMERCE IN DRUGS

The **commercial origin** of a drug refers to its production and its channels of trade. Drugs frequently bear a geographical name indicating the country or region in which they are collected, the country or city from which they are shipped, or to indicate a certain variety. English hyoscyamus leaves are gathered from plants grown in England; Canton rhubarb is the product of plants growing in various parts of China, but shipped by way of Canton; Spanish licorice is a botanical variety of *Glycyrrhiza glabra*, originally produced in Spain but now produced elsewhere, and Virginia snake-root is a species of *Aristolochia* which may or may not come from Virginia. The commercial origin may change in course of time as mentioned in the previous chapter with cinchona, vanilla and coca.

Vegetable drugs are brought into the market in various **commercial forms.** Crude drugs may be nearly entire as seeds, flowers, fruits, leaves, and some roots

and rhizomes; or they may be cut, broken or sliced, as in woods, barks, many roots and a few rhizomes. They may be more or less matted together, as in chondrus and the baled leaves; they may be pressed together by hydraulic pressı ered and then molde m is removed. as in Mexican sarsapari ich a mass of the bı roots, or the roots pieces, or be coarse ts a very different appearance, yet all are the same drug.

Packaging is often characteristic for certain drugs. Socotrine aloe may be packaged in skins, while Curaçao aloe comes in globular gourds of various sizes. Great compressed bales wrapped in burlap, or boxes,

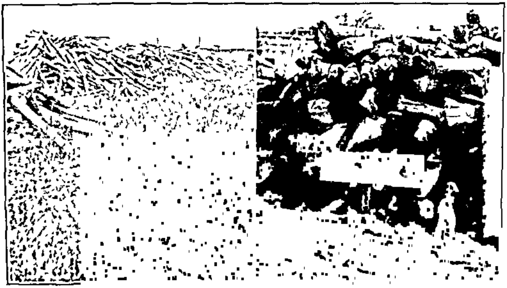

Fig. 7.—Quassia logs at the plant of a pharmaceutical manufacturer near Chicago, after arrival of shipment by boat and train from the West Indies (Photos by Paul D. Carpenter)

barrels and casks, or bags and sacks of various materials are all common forms of packaging. Matting-covered packages of cinnamon from China, seroons of cowhide containing sarsaparilla from South America, square kerosene cans with balsam of Peru from Central America, lead flasks of oil of rose from Bulgaria, shiploads of quassia logs from the West Indies, and many other odd forms of shipment are noted in the drug trade.

London and Amsterdam were until recently the great **primary markets** for drugs Man in London. and at state the "drug auction. The broker also issued a catalog listing the merchandise on display at his office or warehouse, the date of sale, and other information This afforded prospective buyers an opportunity to inspect the drugs and be prepared for the auction. Amsterdam was a "free port" and many drugs from

the East Indies (coca, cinchona, rubber) were handled through it, without Dutch import and export tariffs.

Many of the drugs arriving at a central port for further distribution were "worked" by "bulking" and "garbling." All of the packages of the same drug in a shipment were opened and emptied onto the floor, then carefully garbled and sometimes graded and then repackaged at variable prices. At this stage some operators were tempted to recondition items of poor quality so that they might pass inspection.

Since World War I there has been a tendency on the part of foreign shippers to sell directly to dealers in Europe and America. Goods are usually purchased prior to shipment New York City is the principal port of entry into the United States, although Boston, Baltimore, Atlanta, New Orleans and San Francisco also handle some traffic in drugs. All items arriving at these ports are thoroughly inspected by the customs service and by inspectors of the Food and Drug Administration. Before they are permitted to enter they must meet the requirements of U S. Pharmacopœia, the National Formulary or other standards set down by the Administration.

Since World War II, most of the drug items have been shipped directly to New York from the producing areas. In many of these producing areas, or in small countries, the farmer sells his wares to a local government agency, very commonly the bank of the country. This agency finances and supervises the smaller projects, their collection, grading and packaging and finally arranges for the sale of the drug items, usually by direct contact with the foreign buyer.

Native American drugs are often collected by individuals who in turn sell them to jobbers or directly to manufacturing plants. Large drug brokers such as S. B. Penick & Company have buyers in the collecting areas, and often employ individuals to collect. Some collectors as E. C. Moran, of Stanford, Montana, sell directly to brokers and manufacturers The small operator, whether he be a collector or [illegible] 'rug markets, which fluctuate considerably [illegible] During the past ten years, belladonna le[illegible] ents a pound and as high as $3 25 a pound This, of course, represents an extreme case.

THE PHARMACOPŒIA AND FORMULARY

Drugs of outstanding therapeutic value are standardized in the national pharmacopœias, of which about forty are issued at intervals in the nations of the world The United States Pharmacopœia has been revised and reprinted decennially since 1820 and until 1940, when the U. S. Pharmacopœial Convention at Washington, D. C. changed the revision period to five years. The Spanish Edition of the U. S. Pharmacopœia is recognized as the national pharmacopœia in Cuba, the Philippines and Puerto Rico and in a number of Spanish-language countries of Central and South America

The National Formulary was developed by the American Pharmaceutical Association and the first edition was issued in 1888. The second edition was issued in 1896; subsequent editions have been issued concurrently with the Pharmacopœia. The current editions of the Pharmacopœia and the Formulary are authorized in the national and state Pure Food and Drug Laws as the official standard for the items they contain. Items that have been official in the Pharmacopœia or the Formulary, but that are not found in the current issues, are designated as **unofficial**; items that have never appeared in either book may be called **non-official**.

The several issues of the Pharmacopœia and the Formulary are designated as follows:

U. S. Pharmacopœia			National Formulary	
Authorized at convention of	Period official	Revision number	Period official	Edition number
1820	1820 to 1831			
1830	1831 to 1842	I		
1840	1842 to 1851	II		
1850	1851 to 1863	III		
1860	1863 to 1873	IV		
1870	1873 to 1882	V		
1880	1882 to 1894	VI	1888 to 1896	I
1890	1894 to 1905	VII	1896 to 1905	II
1900	1905 to 1916	VIII	1905 to 1916	III
1910	1916 to 1926	IX	1916 to 1926	IV
1920	1926 to 1936	X	1926 to 1936	V
1930	1936 to 1942	XI	1936 to 1942	VI
1940	1942 to 1947	XII	1942 to 1947	VII
1940	1947 to	XIII	1947 to	VIII

In this text-book the official period of each item is stated in the monograph on the item.

To give some idea of the extent and scope of these books of official drug standards the following tabulation has been prepared. It indicates also the great movements (rise and fall), as well as the new development in medication during the life of the Pharmacopœia and the Formulary.

It has been difficult to separate these items into this classification. The Pharmacopœial editions from 1820 to 1870, inclusive, contain two sections, namely: Materia Medica (primary and secondary lists) and Preparations. The materia medica consists almost entirely of plant drugs, with a few items derived from animals. Nearly all of the chemical items are in the section on preparations, where full directions are given for their manufacture. Morphine and quinine sulphate appear in the 1830 Pharmacopœia; both are found in the preparations section, with full directions for extracting the alkaloids from opium and cinchona bark respectively

Hundreds of items first listed as Preparations are now definitely assigned to other groups, such as inorganic and organic chemicals. Pepsin and pancreatin first appeared in N.F. I as preparations, with full directions for preparing them. Cod liver oil, now recognized as a vitamin drug of animal origin, was admitted to the Pharmacopœia of 1850, long before vitamins were known. We have drugs in the Pharmacopœia today that are definitely plant or animal parts, yet are used exclusively for their vitamin or hormone activity; where should they be classed? In the tabulation below, drugs are classed as they are generally assigned today.

A detailed classification of the preparations gives further enlightenment as to the rise and fall of classes of medication, as well as to the great variety of pharmaceutical preparations.

U. S. PHARMACOPŒIA AND NATIONAL FORMULARY DRUGS DERIVED

	From Plants					From Animals					From Chemicals				
	Crude drugs	Chemicals*	Vitamins	Enzymes	Bacteria, yeasts and molds	Animal parts	Chemicals	Enzymes	Vitamins	Endocrines hormones	Inorganic	Organic	Total materia medica	Preparations	Grand total
U.S.P. 1820	245	7			1‡	17					101	2	373	267	640
U.S.P. I	264	11				19					91	5	390	235	625
U.S.P. II	286	13				20					98	9	426	278	704
U.S.P. III	290	18				24			1§		112	6	451	320	771
U.S.P. IV	309	24			1	20	2		1		131	9	500	374	874
U.S.P. V	315	26			1	19	2		1		160	14	538	437	975
U.S.P. VI	277	43		2†		19	3	2	1		169	18	534	466	
N.F. I	3	2				3		4			5	4	21	108	1429
U.S.P. VII	259	56				22		3	1		173	27	541	457	
N.F. II	4	2				3		1			6	3	19	144	1461
U.S.P. VIII	227	71		2	1	19	4	3	1	2	159	17	537	412	
N.F. III	2	3				4		2			13	3	27	542	1518
U.S.P. IX	168	74		3	7	16	4	2	1	3	146	49	473	308	
N.F. IV	139	11			1	9	1	2			35	5	203	581	1565
U.S.P. X	130	62		1	1	11	4	2	1	6	110	73	404	223	
N.F. V	152	10			1	8	1	2			13	9	226	553	1406
U.S.P. XI	107	59		1	13	13	5	2	2	9	109	77	397	174	
N.F. VI	123	22				6	1	2		6	47	18	225	160	1256
U.S.P. XII	97	69	8	1	19	18	10	1	7	10	106	84	429	231	
N.F. VII	137	28				6	1	3		6	63	28	272	164	1396
U.S.P. XIII	76	60	5		28	20	1	1	5	17	98	93	407	264	
N.F. VIII	124	32		1	4	6	2	3		5	81	61	320	103	1394

* Plant chemicals include alkaloids, glycosides; distilled oils and waters; expressed oils and fats; extracted acids, sugars and juices; etc. Such chemicals largely produced synthetically are included in organic chemicals.

† Malt, Malt Extract and Diastase.

‡ Yeast.

§ Cod Liver Oil.

Preparations	U S Pharmacopœia 1820	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	National Formulary I	II	III	IV	V	VI	VII	VIII
Abstracta, Abstracts							11															
Aceta, Vinegars	3	2	3	4	6	5	4	2	2	1	1	1			1	3	3	2	1		1	1
Acida, Acids	2	3	5	5	8	8	7	8	8	8	5	5	3	1	3	5	3	.	1	1	2	4
Alcohol (Diluted)	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Ampullæ, Ampuls																		.	8	29	18	23
Aquæ, Waters	9	9	9	8	13	14	12	19	13	14	9	10	9	8	3	2	1	1	2	3	3	4
Balsamum															1	1	1					
Boroglycerina															1	1	1					
Cæmentum, Dental Cement															.					..	1	1
Capsulæ, Capsules													12	15								9
Cataplasma									1									1	1	1	1	1
Cerata, Cerates	11	11	9	10	10	10	8	6	6	3	3	3	2	.	1	3	4	3	3	2	3	5
Chartæ, Papers						2	3	2	1		.				.	1	2	1	1			
Collodia, Collodions				1	2	3	4	4	4	3	2	2	2	2	4	4	4	5	3	2	2	1
Collyria, Eye Washes	4																					
Confectiones, Confections	6	7	5	5	5	5	2	2	2								.	2	2			
Cordiale, Cordial								..							1	1	1	1				
Curatio, Dressing																			1	1		
Decocta, Decoctions	15	11	12	12	12	12	3	3	1	1	1	1	1		1	1	3	1				
Denticoni, Dentalcones							.							1								
Dentifricium, Dentifrice										.		.						.	1	1	1	1
Dentilinimenta, Dentaliniments																			2	1	1	
Elixira, Elixirs							1	2	3	2	2	2	2	2	86	91	89	77	66	54	52	39
Emplastra, Plasters	8	9	11	13	16	17	17	15	7	7	6	4	4	3	3	7	13	2	2	1	2	2
Emulsa, Emulsions								4	6	4	3	4	4	2	11	12	12	9	6	4	4	4
Essentia, Essence																	1					
Extracta, Extracts	16	16	24	30	34	36	31	34	27	23	13	10	7	5	2	5	13	14	14	14	15	11
Fluidextracta, Fluidextracts				8	25	45	79	87	85	50	27	12	10	7	52	45	53	90	105	72	72	31
Fluidglycerata, Fluidglycerates																		6	6	1	1	
Gargarisma, Gargle							.	..	.	..	.		.					1	1	1	1	1
Gelata, Jellies				.					.		.		2	3						1	1	2
Gelatinum, Gelatin	.			.	.	.				1	1	1	1	1	1	1	1	1				
Glycerita, Glycerites	.					5	2	6	6	5							5	5	5	1	1	1
Glycerogelatina, Glycerogelatines	.					.					4	3	3	3	7	7	6	6	5	6	6	3
Infusa, Infusions	23	20	27	32	31	31	6	5	4	3	2	1	1		2	3	4	5	4	3	3	1
Inhalatio, *Inhalation*														1								
Injectiones, Injections						.			.		..		23	42								
Inuncta, Inunctions						.																
Lavatio, Wash						.	..	..	..						.			2	2 1			
Linimenta, Linaments	9	6	6	6	7	9	10	9	8	8	5	4	4	4	8	11	11	9	10	9	10	10

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U.S.P. XIII	76	60	5		28	20	4	1	5	17	98	93	407	284	
N.F. VIII	124	32		1	4	6	2	3		5	81	61	320	403	1394

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Preparations	U S Pharmacopœia 1820	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	National Formulary I	II	III	IV	V	VI	VII	VIII
Abstracta, Abstracts							11															
Aceta, Vinegars	3	2	3	4	6	5	4	2	2	1	1	1			1	3	3	2	1		1	1
Acida, Acids	2	3	5	5	8	8	7	8	8	8	5	5	3	1	3	5	3		1	1	2	4
Alcohol (Diluted)	1	1	1	1	1	1	1	1	1	1	1	1	1	1								
Ampullæ, Ampuls																			8	29	18	23
Aquæ, Waters	9	9	9	8	13	14	12	19	13	14	9	10	9	8	3	2	1	1	2	3	3	4
Balsamum															1	1	1					
Boroglycerina															1	1	1					
Cæmentum, Dental Cement																					1	1
Capsulæ, Capsules													12	15								9
Cataplasma									1									1	1	1	1	1
Cerata, Cerates	11	11	9	10	10	10	8	6	6	3	3	3	2		1	3	4	3	3	2	3	5
Chartæ, Papers						2	3	2	1							1	2	1	1			
Collodia, Collodions				1	2	3	4	4	4	3	2	2	2	2	4	4	4	5	3	2	2	1
Collyria, Eye Washes	4																					
Confectiones, Confections	6	7	5	5	5	5	2	2	2									2	2			
Cordiale, Cordial															1	1	1	1				
Curatio, Dressing																			1	1		
Decocta, Decoctions	15	11	12	12	12	12	3	3	1	1	1	1	1		1	1	3	1				
Denticoni, Dentalcones														1								
Dentifricium, Dentifrice																			1	1	1	1
Dentilinimenta, Dentaliniments																			2	1	1	
Elixira, Elixirs							1	2	3	2	2	2	2	2	86	91	89	77	66	54	52	39
Emplastra, Plasters	8	9	11	13	16	17	17	15	7	7	6	4	4	3	3	7	13	2	2	1	2	2
Emulsa, Emulsions								4	6	4	3	4	4	2	11	12	12	9	6	4	4	4
Essentia, Essence																	1					
Extracta, Extracts	16	16	24	30	34	36	31	34	27	23	13	10	7	5	2	5	13	14	14	14	15	11
Fluidextracta, Fluidextracts				8	25	45	79	87	85	50	27	12	10	7	52	45	53	90	105	72	72	31
Fluidglycerata, Fluidglycerates																		8	6	1	1	
Gargarisma, Gargle																		1	1	1	1	1
Gelata, Jellies													2	3						1	1	2
Gelatinum, Gelatin										1	1	1	1	1	1	1	1	1				
Glycerita, Glycerites						5	2	6	6	5							5	5	5	1	1	1
Glycerogelatina, Glycerogelatines											4	3	3	3	7	7	6	6	5	6	6	3
Infusa, Infusions	23	20	27	32	31	31	6	5	4	3	2	1	1		2	3	4	5	4	3	3	1
Inhalatio, Inhalation														1								
Injectiones, Injections													23	42								
Inuncta, Inunctions																		2	2			
Lavatio, Wash																			1			
Linimenta, Liniments	9	6	6	6	7	9	10	9	8	8	5	4	4	4	8	11	11	9	10	9	10	10

olutions	11	11	14	19	21	27	26	24	25	25	23	17	16	20	41	45	55	52	37	32	39	41
otions														2	4	4	4	4	7	6	8	7
lagmas										2	1	2	1	2			1	1	1	1	2	1
asses							3	3	2	2	2	2	1				1	1	1		1	2
Oxymel, Honeys	3	3	4	3	3	3	2	2	2	1	1				1	1	1	3	3	1	1	
Mixtures	9	5	5	6	8	8	11	4	4	2	2	2	1	1	19	20	20	20	13	4	5	5
es, Mucilages		1	2	2	4	4	5	4	4	2	2	2	2	2	3	4	4	2	2	1	1	1
lls																	5	5	5			
prays													1					5	5	4	4	4
um, Toothache Drops																			1	1	1	1
(medicated)	1	1	1	2	2	2	2	2	1			1	1	1	3	3	3	6	6	4	4	3
ates							2	3	5	1	1	1	1	1	4	4	3	5	2			
, Oleoresins					5	6	6	6	6	6	2	1	1	1				1	1	3	3	3
ra, Oil Sugars															1	1	1	1	1	1	1	
næ, Oil Vitamins														4								
e Melata)																						
te																	8	8	8	8	10	10
ı, Petroxolins																	2	20	18	3	3	1
s	23	13	17	18	19	19	15	15	14	7	5	2	1	1	22	22	24	31	24	13	14	10
owders	8	3	4	4	7	6	9	9	9	7	6	4	2	1	15	17	19	14	13	7	9	11
										3	2	2	2	2	7	12	12	11	10	10	10	
Resin Solutions																			2			
as															3	3	3	3	3			
irits	7	11	10	10	15	17	20	23	18	15	9	9	8	6	12	9	14	9	11	10	12	14
s																	3	2	2			
s															1	1	1	1				
æ, Suppositories						9	1	2	2	2	2	2	2	1			1	1	1	1	1	
ups	15	14	16	20	23	25	34	32	28	22	18	14	13	12	35	38	45	45	38	25	25	24
blets												1	47	63					8	48	32	51
Tinctures	51	48	56	60	56	57	73	72	64	50	41	31	22	18	33	32	46	50	56	47	54	35
es, Triturations							2	2	2	2	1	1	1									
roches	3	3	5	6	9	13	16	15	9	5	2			1		2	9	9	2	1	1	
Ointments	10	18	22	25	23	29	26	22	24	20	18	16	17	20	5	7	11	12	19	21	22	21
s	10	9	10	10	10	9	12	8	8						12	15	15	15				1
us														4								2
Totals	267	235	278	320	374	437	466	457	412	308	223	174	231	264	408	444	542	581	553	460	464	403

OFFICIAL AND UNOFFICIAL DRUGS

In U. S. Pharmacopœia XIII and National Formulary VIII (1947), each monograph is headed by the English Title, which is immediately followed by the Latin Title. This is an innovation, for all of the preceding editions of each book had the Latin Title as the first and major title of each monograph. The alphabetical arrangement of the English titles also gave opportunity to group the preparations of the drug adjacent to the drug monograph, and this is considered to be an advantage to physician and pharmacist in the use of the book.

The **Official Title** heads the monograph and is in **English.** This is immediately followed by the **Latin** title. In the case of vegetable drugs, these titles are derived either from the generic or specific name of the plant yielding the drug (gelsemium from *Gelsemium sempervirens* or ipecacuanha from *Cephaelis ipecacuanha*); from the entire botanical name, if more than one drug is derived from the same genus (viburnum prunifolium and viburnum opulus from *Viburnum prunifolium* and *Viburnum opulus*, respectively), from the generic or specific name combined with the plant part, when two drugs are derived from the same plant (colchicum seed and colchicum corm from *Colchicum autumnale*, or belladonna leaf and belladonna root from *Atropa belladonna*); or from local or native names (opium, sarsaparilla, cascara sagrada).

Synonyms, which are usually vernacular names, are frequently applied to a drug. In the official monographs the use of synonyms is discouraged, for it is considered more proper for trained professional persons such as physicians and pharmacists to use the official titles Furthermore, the use of synonyms frequently leads to confusion in the collection, the commerce and the dispensing of drugs; for instance the term "snakeroot," which has been applied to at least twelve different drugs, frequently causes uncertainty as to what is wanted.

The **official definition** is given in the leading paragraph of the monograph and includes the botanical or zoölogical source, as well as the name of the part or parts constituting the drug, together with their condition (ripe, unripe, dried, fresh, etc.), in some cases other special features or requirements are given, as the geographical or commercial origin, the time of collection or manner of preparation, etc.

The **official rubric** immediately follows the official definition and includes the standards of strength which the drug must attain. These standards may include the amount of active constituent or the degree of biological activity required of the drug.

The **official description** establishes means to identify the drug and to determine its purity. It sets forth the external appearance of the "whole" drug and usually the appearance of the drug structure when sections are viewed under the microscope. Often a description of the salient features of the powder is also given.

The **official tests** aid especially in the determination of the quality and purity of the drug, rather than the identity, though some tests do serve to identify.

The tests as found in the official drug monographs are not numerous, yet may be classified as follows: (1) morphological, as "Unground Salvia contains no leaves that are broad, dark green or with a cordate base (*absence of other Salvia species*)"; (2) microscopic, as "Powdered Salvia does not contain stellate hairs (*absence of Phlomis species*)"; (3) pharmaceutical, as "Boil 1 part of Chondrus for about ten minutes with 30 parts of water, replacing the water lost by evaporation; the strained liquid forms a thick jelly upon cooling"; (4) chemical, as "Cubeb, powdered or crushed and mixed with sulfuric acid, produces a crimson coloration of the acid."

The **official purity requirements** and **tests** state the limits of permissible foreign matter and often name common adulterants and present means for their detection.

The **official assays** are elaborate tests designed to determine the amount of an active ingredient present in the drug, or sometimes to determine the amount of inert matter present. Drug assays may be (1) proximate, where the alkaloidal content is determined, as with belladonna leaf or areca; (2) extractive, where the amount of extractive obtained with any specific solvent is determined, as the ether-soluble extractive (ginger), the alcohol-soluble extractive (gamboge), or the water-soluble extractive (gambir); (3) physical, such as the determination of the volatile oil content of a drug by distillation (salvia); (4) chemical, such as the assay for hydrogen cyanide in bitter almond; (5) biological, where the effect of the drug upon an animal is compared with the effect of a standard upon the same kind of animal, as the digitalis or ergot assays; (6) colorimetric, where the tinctorial power of a drug is compared with a color standard, as the saffron or cudbear assays; (7) peptic, as the pepsin assay; (8) coagulative, as the rennin assay; (9) diastatic, as the malt assay; and many other kinds.

The **preservation** and **storage** of vegetable drugs is frequently referred to in the official monograph. (For further discussion of this subject see page 22.)

The **official dose** of drugs used internally is usually included in the monograph as a guide to physician and pharmacist, but is not obligatory upon either. Usually the average dose is given, and this for a single oral dose for an adult human. Occasionally an average dose is also given for children, or a daily dose is given (see emetine hydrochloride). Sometimes the dose is specified for animals (see areca), and sometimes it is specified to be given parenterally (see emetine hydrochloride), hypodermically (see epinephrine), or intravenously (see arsphenamine).

THE EVALUATION OF DRUGS

The analytical side of pharmacognosy is embraced in the expression "the evaluation of drugs," for this includes the identification of a drug and the determination of its quality and purity.

The Identification of a Drug

The identity of a drug is of first importance, for little consideration can be given to an unknown drug as regards its quality and purity.

The identity of a drug can be established by actual collection of the drug from a plant or animal which has been positively identified from the botanical or zoological standpoint. [illegible] an investigator of the drug, who m [illegible] his samples. For this reason "drug gar [illegible] ection with [illegible] with a known true sample [illegible] lrug A third method, and the most common among pharmacognosists, is by an acquired knowledge of [illegible] e true drug. A classic example of wrong identi- [illegible] of American pharmacognosy The bark of the [illegible] *opulus*), long used in American medicine and official in the Pharmacopœia and then in the National Formulary, became entirely substituted commercially with the bark of the mountain maple (*Acer spicatum*), a similar shrub. This fact was not recognized, and the official description for two decades was that of the substitute and not of the true drug.

The Quality of a Drug

Quality refers to the intrinsic value of the drug, that is, to the amount of medicinal principles or active constituents present in the drug. These principles or constituents belong to a group of non-protoplasmic cell contents and will be found classified into groups in the section on "The Chemistry of Drugs." (See page 45.)

A high grade of quality in a drug is of such importance that effort should be made to obtain and maintain this high quality. The most important factors to accomplish this have been covered in the section on "The Production of Drugs," (page 17). They include (1) the collection of the drug from the correct natural source at the proper time and in the proper manner; (2) the preparation of the collected drug by proper cleaning, drying and garbling; and (3) the proper preservation of the clean, dry, pure drug against contamination with dirt, moisture, fungi, filth and insects.

The Purity of a Drug

The **purity** of drugs depends upon the absence of foreign matter. In the collection of a drug and its preparation for the market it is hardly possible to attain a state of absolute purity, and a limited amount of innocuous, extraneous matter adhering to the drug or admixed with it is usually not detrimental. **Foreign organic matter** refers to any part of the plant or plants yielding the drug, except that part or those parts designated as constituting the drug, and to any other plant parts, or vegetable or animal tissues or substances. The permissible percentage of foreign organic matter in a drug is usually specified in its monograph. **Foreign inorganic matter,** such as adhering dirt and sand, may be determined by the acid-insoluble ash method, though some drugs contain

acid-insoluble ash that is natural to the drug. In the Pharmacopœia, a maximum of 2 per cent of acid-insoluble ash is permitted, unless otherwise stated in the monograph. **Moisture** is normally present, even in the dried drug, to the extent of from 5 to 10 per cent. An excess of moisture is considered as an adulterant.

Adulteration, in the broad and legal sense, is the debasement of any article

Adulteration involves.

(*a*) **Sophistication or True Adulteration.**—The addition of a spurious or inferior material to any article with intent to defraud. The addition of wheat flour to powdered ginger, with enough capsicum to restore or enhance the

it is sophistication. Buchu containing a few stems or sarsaparilla root with some adhering dirt would class as admixtures. If in any case an admixture exceeds the established standard, it becomes legally an adulteration.

(*c*) **Substitution.**—An entirely different article used or sold in place of the one required or asked for. A complete substitution, even though intentional and fraudulent, is not sophistication, as none of the true article is present. However, all substitution is considered legally as adulteration. Cotton-seed oil sold as olive oil, and American saffron sold as Spanish saffron are examples of substitution

(*d*) **Deterioration.** An impairment of the quality or value of an article by the abstraction or destruction of valuable constituents by distillation, extraction, aging, moisture, heat, fungi, insects or other means Whole cloves from which part of the volatile oil has been removed by distillation ("spent" cloves); ground linseed from which part of the fixed oil has been expressed (linseed cake); lard in which the fats have to some extent decomposed to form fatty acids (rancid lard); powdered squill that has hardened through absorption of moisture, coffee that has largely lost its caffeine through over-roasting; ergot that is moldy; and rhubarb that has become "wormy" are examples of deterioration

(*e*) **Spoilage.**—A form of deterioration in which the quality or value or usefulness of an article is so impaired or destroyed by the action of fungi as to render the article unfit for human consumption. Many examples of spoilage are found, especially of fresh or canned fruit, vegetables, meats, fish, etc. All drugs which are unfit for human or other animal consumption are legally considered as adulterated

(*f*) **Inferiority.**—Inferiority, in the broad sense, is any substandard condition from any cause. The more restricted definition as applied to foods, drugs and materials produced by Nature indicates a natural substandard condition.

or deteriorated.

Milk, offered for sale at retail, is usually required to contain not less than 3 per cent of butter fat If milk containing 4 per cent of butter fat has water added to it so as to reduce the butter fat to 3 per cent, it is considered adulterated; but if the same milk has all the butter fat separated from it in the form of cream and then just enough of this cream be restored to the milk so as to give the required 3 per cent of butter fat, it will not be considered as adulterated.

A somewhat similar procedure is being followed with some drugs, notably opium and hydrastis The standard for hydrastis is not less than 2 5 per cent of ether-soluble alkaloids. Powdered hydrastis containing a higher percentage

of alkaloids may be admixed with inferior hydrastis or exhausted hydrastis to bring the amount of alkaloids in the mixture to 2 5 per cent or a little more. Such an admixture is not construed as adulteration, though by some the practice is considered as reprehensible

Substances used as **adulterants** of drugs are almost innumerable. In addition to those mentioned above, especial mention should be made of pieces of iron or lead used to increase weight as in opium and Burgundy pitch and also inserted into fresh ginseng root; pebbles and sand admixed with asafetida; and large masses of dirt placed in the middle of bundles of sarsaparilla root.

Adulteration of foods, spices and dr
years of the nineteenth century, but s
lent up to the latter years of this centu
food supply of the country one-seventh is adulterated." One can readily obtain figures in the pharmaceutical journals of 1850 to 1910 showing that something like 50 per cent of the powdered drugs upon the market were adulterated The trade in spices was even worse, for we read that "the adulteration of spices is a practice so common that we would really be surprised to find goods pass through the grocery trade that are absolutely pure." This condition, of course, could not continue indefinitely, and fortunately a few manufacturers, who valued the reputation of their products even more than the money they could make out of them, lent support to national and state legislation which should fix standards of purity for foods and drugs. This finally ended in the passage of the Federal Food and Drugs Act in 1906, which was followed by cooperative

nforcement of the laws,
ceased

In 1938, because of certain shortcomings in the Act of 1906, Congress passed a more comprehensive statute, The Federal Food, Drug and Cosmetic Act, which prohibits the movement in interstate commerce of adulterated and misbranded foods, drugs, devices and cosmetics. The federal law is administered by the Food and Drug Administration, a division of the Federal Security Agency. The Food and Drug Administration maintains its central laboratories at Washington, that having the most to do with drug inspection being the Microanalytical Division. The Administration also maintains branch laboratories and corps of inspectors in the principal cities of the United States. Many of their special analytical methods (not found in the U S Pharmacopœia or the National Formulary) are published in Food and Drug Circular No. 1, "The Microanalysis of Food and Drug Products."

The **evaluation of a drug** involves a number of methods which may be classified as follows: (1) organoleptic, (2) microscopic, (3) biological, (4) chemical, (5) physical

The Organoleptic Evaluation of Drugs

Organoleptic (lit. "impression on the organs") refers to evaluation by means of the organs of sense, and includes the macroscopic appearance of the drug, its odor and taste, occasionally the sound or "snap" of its fracture, and the "feel" of the drug to the touch.

For convenience of description the macroscopic characteristics of a drug may be divided into four headings, viz.: (1) shape and size; (2) color and external markings; (3) fracture and internal color; (4) odor

and taste. In some official crude drug monographs the entire description is an organoleptic evaluation and the only means of evaluation that is given. Somewhat different terms are used for describing drugs from different parts of the plant, as follows:

A.—Drugs derived from underground parts of the plant, such as rhizomes, roots, bulbs, corms, tubers, etc., occur either (1) entire, (2) in longitudinal slices, (3) in oblique or transverse slices, (4) cut in small cubical pieces, or (5) broken into pieces.

In **shape** they may be (1) cylindrical, as sarsaparilla; (2) cylindraceous or subcylindrical or nearly cylindrical, as podophyllum; (3) conical, as aconite; (4) fusiform (enlarged in the middle and tapering toward the ends), ovoid (egg-shaped) or pyriform (pear-shaped), as jalap; (5) terete (tapering gradually but nearly cylindrical), as stillingia; or (6) disk-shaped, as calumba.

They may be simple or branched and are frequently curved and twisted. In the case of rhizomes, the direction of growth is often considered. This is usually horizontal, but may be oblique and in a few cases is vertical. The direc-tic ttachment of the roots and stem-bases. ter and in the most convenient terms, eit (cm.). In cases where the shape is conical, the diameter of both wide and narrow parts may be of importance.

The **external color** varies from white (where the drugs have been deprived of the periderm) through yellowish gray, yellowish brown, reddish orange, to even brownish black It is often more or less gray from clay dust. (See page 38.)

External markings may be classified as follows: (1) furrows—alternating ridges and valleys which are more or less parallel, well-defined, and usually due to the shrinkage of the internal parts caused by drying; (2) wrinkles—fine or delicate furrows; (3) annulations—transverse ring-like markings; (4) fissures —splits extending into the tissues, (5) nodules—rounded outgrowths on the surface, (6) projections, such as roots, stem-bases and buds; (7) scars, such as leaf scars, stem-base scars, root scars, bud scars, bud-scale scars.

The **fracture** has to do with the way the plant part breaks when subjected to sufficient pressure. Often th than the non-woody portion. T (1) complete, breaking clean a across; (3) short, a clean smooth break with a quick snap; (4) fibrous, a slow giving break accompanied by resistance and characterized by the projection of fibers from the broken surfaces; (5) splintery, breaking irregularly across into pieces with larger and smaller projecting edges and splinters; (6) brittle, easily broken, usually into many pieces when dropped onto a hard surface; (7) tough, breaking with difficulty, (8) weak, breaking with little effort.

In many cases the nature of the fractured surface is as important as the fracture itself. Terms used to describe the fractured surface are as follows:

an abundance of starch (starchy); conchoidal, a resinous surface char convex and concave fashion, (9) waxy, exhibiting a dull wax-like surface. Other descriptive terms as dull, smooth, rough, etc , are also used in describing the fractured surface.

The color of the fractured surface is known as the **internal color.**

B.—The bark refers to that portion of the woody exogenous stem or root that lies outside of the cambium ring. The majority of official barks have periderm present, yet in some cases, as sassafras and slippery elm, this has been removed. In the entire state, barks occur in three shapes: (1) flat or transversely curved pieces; (2) single quills (rolled from one edge), (3) double quills (rolled from both edges). The most important **measurement** is the thickness of

the bark. In the case of quills, both the diameter and the length should also be observed while with flat pieces measurements of the length and breadth may be made.

Barks have two surfaces, an outer and an inner, and both are described. The **external color** of barks on both outer and inner surfaces usually varies from brownish gray to brownish black. The inner surface is usually lighter in color than the outer, and in some cases is almost white.

The **markings** on the outer surface of barks are often characteristic, such as (1) lenticels, (2) lichens with their apothecia, (3) corky ridges, warts or prickles, (4) fissures and (5) adhering mosses. The inner surface may be smooth or marked with fine parallel lines (striations) due to the inner fibers of the phloem. Occasionally crystals are found on the inner surface of barks.

The **fracture** of barks may vary from short and weak to tough and fibrous. The examination of the fractured surface includes **color** and the presence or absence of projecting bast fibers and stone cells. In many cases the nature of the fracture of the cortical region differs from that of the phloem region.

C.—The wood refers to that part of the woody exogenous stem or root that

That portion of the wood which lies near the cam-

the vegetative process of the plant is known as

white; while the inner layers of wood which have ceased to function in the transportation of sap form the heartwood which is often highly colored Red saunders is an example of heartwood.

Woods occur in the form of chips, raspings and shavings. Their **external surfaces** are usually striated from fibers or porous from tracheæ. The **external color** varies widely. The **fracture** is usually tough and fibrous while the **internal color** is the same as the external color.

D —Leaves and leaflets are described with the usual botanical terms The length and width of the bla

blade, together with that of

markings include the venati

characters of the upper and

described (soft, harsh, smooth). The **color** is included under the description of the surfaces

Many of the leaves occur in a more or less crumpled condition, and such specimens should be macerated in water and then spread out for study The **fracture** of leaves unless particularly characteristic is usually of no importance in identification.

F.—Fruits and seeds vary greatly as to shape. The usual forms are globular, ellipsoidal, ovoid, reniform, conical, etc Two or three dimensions are to be noted as the case may be. Often only a portion of the fruit is official (bitter orange peel). The usual **markings** of fruits consist of attachment scars and the scars or remains of various floral parts. Many of the fruits, especially the drupes, show a wrinkled pericarp surface. These wrinkles are often characteristically netted or reti

testa, hilum and micr

cotyledons are seen.

tance.

G.—Those items sold as crude drugs which do not possess a definite histological (or cell) structure may be products formed in the metabolic processes of the plant, they may be pathological products, or they may have undergone some special pharmaceutical or physical treatment The group includes items such as gums, resins, gum-resins, mucilages, oleoresins, inspissated juices, latex, tars, extracts, etc. They may occur in (1) tears, small rounded masses formed

naturally as the exudation ha [illegible] en-up material that has hardened in the co [illegible] arder portions massed with soft material. C [illegible] varying from a liquid to a semiplastic mass. Only in the case of tears is the **size** of importance. In the cases of solids, **fracture** and **fractured surface** are important. **Color** is [illegible]

H.—. [illegible] usually [illegible] characters. They will be considered in the drug monographs under the heading of Active Constituents.

I.—A miscellaneous group comprising such items as starches (amylum), excrescences (galls), trichomes (lupulin), sclerotia (ergot), diatom frustules (purified siliceous earth), etc., are of relatively rare occurrence, but the usual characteristics of **size, shape, color, markings,** etc., are determined either macroscopically or microscopically.

The **odor** of a drug may be either distinct or indistinct, depending upon the amount of volatile constituents the drug possesses. General terms used in describing odor are aromatic, balsamic, spicy, alliaceous, camphoraceous, terebinthinate, etc. These terms are comparative with other substances in Nature. When no such correlation can be made and the odor is distinct, it is said to be characteristic.

Taste may be defined as a particular sensation excited by certain substances when these are brought into contact with special organs situated in portions of the epithelial layer of the mouth. It is that sense by which we perceive the characteristic or distinctive savor of soluble substances when these are placed in the mouth and moistened with saliva. The taste of a substance is the quality or savor of the substance perceived in this way Substances may be classified according to taste into the four following groups.

1. Those possessing a true taste, that is, exciting the sensation referred to above. Such tastes are (*a*) acid or sour, (*b*) saline or salty, (*c*) saccharine or sweet, (*d*) alkaline, (*e*) bitter.

2. Those possessing no taste, and hence are tasteless or insipid. This group includes all substances insoluble in the saliva.

3. Those possessing a characteristic odor which gives name to the so-called "taste." With this a true taste may or may not be associated. Such tastes may be grouped broadly into those which are agreeable, including (*a*) aromatic, (*b*) balsamic, (*c*) spicy, and disagreeable, including (*i*) alliaceous, (*ii*) camphoraceous, (*iii*) terebinthinate.

4. Those imparting distinctive sensations to the tongue, exclusive of taste or t[illegible] sub[illegible] feel [illegible] pro[illegible] (*d*) [illegible] an [illegible] excite vomiting.

A drug frequently gives more than one taste, the sensations usually being observed in consecutive order. The first taste noted is produced by the most soluble constituent.

The **color** of drugs whether whole or powdered or in microscopic section is determined by the Inter-Society Color Council-National Bureau of Standards method. The color names indicated in the official monographs are official standards of equal importance to the other organoleptic specifications. [illegible]

[illegible] use of ISCC-NBS charts. The National Formulary includes a complete description of the application of the method.

The Microscopic Evaluation of Drugs

The microscope has been employed in the examination of drugs since 1847, when Schleiden used it in the examination of the sarsaparillas. In 1853 Schacht showed its value in the examination of textile fibers. The earliest reference in English to the use of the microscope as a means of detecting the admixture or adulteration of drugs is the statement of Professor Pereira in his introductory lecture before the Pharmaceutical Society of Great Britain in 1851, when he said: "You are doubtless conversant with the recent very extensive employment of the microscope for disclosing the adulteration of food. No less useful —no less powerful is it in disclosing the contamination of drugs; and I cannot too strenuously recommend you to employ it."

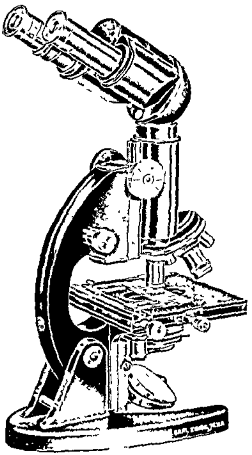


FIG. 8.—Modern compound microscope for research and routine work. Most microscopic examinations may be satisfactorily made without the elaborate equipment shown above, which fits the microscope for photo-micrographic work and any variety of research examinations. A swing-out adjustable condenser, mechanical stage, binocular tube and other accessories are all features of this instrument.

The investigations of Pereira, Hassal and others showed even at that time not only that the microscope had unlimited valuable practical applications, but that it was the only means which had been discovered

to detect the admixture or adulteration of non-crystalline organic substances. An article published in the *American Journal of Pharmacy* in 1853 (pages 45–48) on the use of the microscope in the examination of drugs shows that, in spite of the fact that it had only recently come into general use, its value was very early appreciated.

The microscope, however, is not only essential to the study of **adulterants** in powdered plant and animal drugs, but is of indispensable value in the **identification** of the pure powdered drug. Those sections of the official monograph headed ***histology and powder*** *deal almost exclusively with the microscopic* appearance of the drug in sectional view and powdered form.

Plant parts are made up of tissues, each of which performs a definite function essential to the life of the plant. The histology refers to the character and arrangement of these tissues as they are present in the drug. Some drugs have no cellular structure, as acacia or rosin; some are composed of microscopic units, such as spores (lycopodium) or hairs (lupulin or kamala); with others a knowledge of structure would not be helpful, for they are easily identified macroscopically (chimaphila), or consist of several plant parts (sambucus, adonis); but many drugs possess a characteristic structure helpful in identification of the drug. Histological studies are made from very thin transverse or longitudinal (radial and tangential) slices properly mounted in suitable stains, reagents, or mounting media.

Powdered drugs possess very few macroscopic features of identification outside of color, odor and taste, hence the microscopic characteristics are very important In the powdered drug (which should be reduced to not less than a No 40 powder) the cells are mostly broken, except those with lignified walls, but the cell contents (starch, calcium oxalate crystals, aleurone, etc.) are scattered in the powder and become very evident in the mounted specimen.

To prepare a **mount**, transfer a suitable quantity of the powder to 2 or 3 drops of reagent or mounting medium on the clean slide and mix it well with the liquid Place the cover-slip and by light pressure move the cover-slip in rotary motion to insure an even distribution of the powder under it. A properly prepared mount will just fill the space between slide and cover-slip and will be slightly opaque

The proper **reagent** or **mounting medium** to be used depends on the characteristic tissue element or cell content to be studied; starch is best examined in water mount, lignified tissue such as bast fibers, stone cells, tracheæ, etc. in a phloroglucin mount; calcium oxalate, leaf epidermal tissue, trichomes, etc., in a chloral mount. Special test reagents as iodine, zinc chloriodide, ferric chloride, etc., are also used where occasion demands.

Not only is the microscope useful in the study of the histological elements of drugs and in the detection of adulterants, from the histological standpoint, but it can be used for the **quantitative microanalysis** of admixed or adulterated powders. This is done by counting a specific histological feature in a measured quantity of the unknown powder and comparing the count with that obtained of the same feature in a known standard sample, which sample may be of the designated powder itself, or of the adulterant, or of any one of the mixture of powders Similar methods are used for the counting of mold filaments, mold spores, bacteria, etc.

There is a growing interest in **microchemistry**, that is the study of plant constituents by the application of chemical reagents to microscopic sections of the drug or to a small quantity (a few milligrams) of the powdered drug. Microchemistry affords a means by which the constituents of many drugs may be isolated and identified.

The more common microchemical processes are as follows:

I. Isolation of Constituents.

A.—**Isolation With a Solvent.**—1. Five to 10 mg. of the powdered drug material are placed in a small (½ by 3 inches) test-tube and from 0.5 to 1.0 cc. of a suitable solvent added The test-tube may be corked or covered with the thumb, and shaken; or heat may be applied to facilitate extraction. Two to 3 drops of the extract are filtered onto a slide and the solvent allowed to evaporate. The residue is now ready for identification.

2 Extraction may also be made directly on a slide A few milligrams of the powder are placed in a little pile on the slide, a cover-glass being laid in such a manner [illegible] er-glass lies at a slant The solvent is [illegible] owing thereunder and extracting the [illegible] crystals often appear at the opposite edge, and if reasonable care is exercised most of the mount will be free from particles of the powder

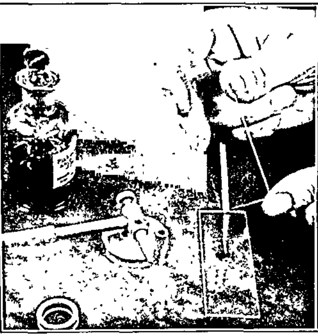


Fig 9

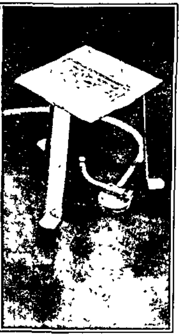


Fig 10

Fig 9 —Microfiltration.
Fig 10 —Microsublimation. (Photos by E H. Wirth.)

[illegible] ed by stirring with a few drops of [illegible] a second slide by microfiltration [illegible] filter paper about 5 cm long into a V-shape, the broad end being 2 to 3 mm. wide The paper is moistened with the solvent and placed upon the extraction slide so that the broad end is in contact with the solvent and drug The extraction slide is now held in tilted [illegible] e filter paper hanging over

[illegible] ituent is sublimable without decomposition (and very many drug constituents are), microsublimation offers a very convenient method for its isolation, often in a purified state.

Microsublimation may be carried out in several ways:

1. A few milligrams of the powdered drug material are placed in a shallow watch-glass, a slide being placed over the powder in such a way as to rest upon

2 mm. between the upper
Heat is carefully applied
nder surface of the slide.

2. The powdered drug material may be placed on a slide and the receiver slide placed obliquely above it in such a manner that one end of the receiver slide rests upon the sublimation slide, the other being supported by a small piece of wood, the distance between powder and receiver slide being about 1 to 2 mm. Both methods allow some escape of the sublimable material.

3. A third and better method is to place the powdered drug material on a slide, covering it with a glass ring about 1 cm. in diameter and 2 to 4 mm. high, over which the receiver slide is placed. The edges of the ring are ground, thus forming a rather tightly closed chamber within which microsublimation may proceed. If the whole is placed upon an asbestos plate (about 4 by 4 inches) having a 1 cm. hole in the center, heat may be applied without unduly raising the temperature of the receiver slide, sublimation being then more efficient.

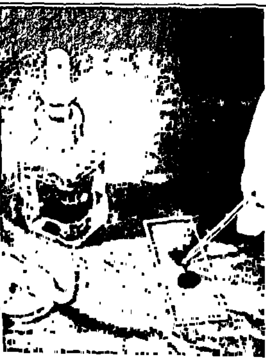


Fig. 11

Fig. 12

Fig. 11.—Testing with reagents on slide.
Fig. 12.—Testing with reagents on spot plate (Photos by E. H. Wirth.)

II. Identification of Constituents.

d further purified, if necessary,
y may be identified by:
the habit of the crystals themselves

2. The melting-point of the crystals, obtained by using the thermal stage.

3. Optical crystallographic characteristics, such as whether the crystal is isotrop ... xial, its type of extinction, optic sign, sign of ... etc.

4. R ... crystalline reaction products or color reactions.

Many reagents give characteristic color reactions with certain compounds. Such color reactions are of value not only in the identification of reaction prod-

ucts but may also be applied to the original sublimates or to the extracted material, and in many cases to the original drug material. Color reactions are best carried out on a white porcelain spot plate, but may be carried out in an evaporating dish or even on a slide, provided the slide is held against a white background.

g

t

knowledge of both crystallography and the optics of crystals, but offers an extremely rapid method for the identification of very small amounts of chemical compounds.

The Biological Evaluation of Drugs

Within recent decades the pharmacological activity of certain drugs has been applied to their evaluation and standardization. A rather distinct group of specialists known as bioassayists has developed, and their work constitutes an important phase of pharmacognosy.

Time and space will not permit of a detailed description of the various types of biotests and bioassays but a brief mention can be made of the organisms used and the methods employed, as follows:

1 Bacteria, such as *Eberthella typhi* and *Staphylococcus aureus*, are used to determine the phenol coefficient or antiseptic value of certain drugs, such as thymol in Liquor Antisepticus, N. F A definite quantity of a recent bouillon ... contact with the specified quantity of ... of time If the living bacteria in the ... during the test, the antiseptic agent meets the required standard

2. Microbiological methods are in common use in the assay of many of the vitamins Yeast, *Saccharomyces cerevisiæ* is used in the assay of thiamine, while *Lactobacillus casei* is used in the assay of riboflavin, biotin and pantothenic acid and *Lactobacillus arabinosus* in the assay of nicotinic acid. A mold, *Neurospora sitophila* is used in the pyridoxine assay

3. Living, microscopic, more or less transparent animal organisms, such as *Daphnia* species, suspended in a microscopic mount, can be observed under

drug can be gauged

digitalis and similar "heart ... he fish are placed in known ... and are transferred from one d ... until a dilution is reached

5 The ... l other members of this gro ... repared dilution of the extract of the drug is compared with a similar preparation of standard digitalis. These dilutions in known quantity are injected into the ventral lymph ... arts is made. The end-point

the change in color from red ... they have been injected with an extract of the drug in various dilutions. A comparison is made with cocks injected with standard solution of ergotoxine ethanesulfonate.

7. Vitamins are standardized against **rats or mice** by noting the results on healthy standard animals that are deprived in their diet of the specific vitamin.

8. Toxins and antitoxins (diphtheria and tetanus) are standardized on **guinea-pigs** of definite weight. The lethal dose of toxin is known as the "toxic unit." An antitoxic unit is that amount of the antitoxin that will preserve the life of the guinea-pig against 100 toxic units of the toxin injected into the animal at the same time.

Posterior pituitary glandular material is standardized by noting the degree of contraction of the isolated guinea-pig uterus in an oxygenated saline bath when exposed to variable dilutions of an extract of the drug. The test is a comparison with standard drug.

Aconite is also tested on guinea-pigs. The suitably diluted tincture is injected subcutaneously and the time of death is noted. A comparison is made with a suitably diluted solution of standard aconitine

9 **Cats** may be used for the standardization of digitalis and similar drugs of this pharmacological group. A definite quantity of a known dilution of the drug is transfused into the blood stream of the cat and the lethal effects are noted and compared with a similar dilution of the standard digitalis.

The **Cat's-eye Test** is of interest in evaluating mydriatic drugs, such as atropine A highly dilute aqueous solution is dropped into the cat's eye and the degree of mydriasis is noted.

10 **Dogs** have been used to standardize cannabis by noting the degree of incoordination in the dog after it has received by mouth a known quantity of an extract of the drug

11. **Humans** have long offered a valuable means of noting the activity of drugs. Only recently, however, have drugs been officially standardized on humans These are drugs such as liver, stomach and other preparations which are used for the treatment of pernicious anemia.

Chemical Evaluation of Drugs

The evaluation of crude drugs by chemical means is followed only to a slight extent. The active constituents of crude drugs, especially when separated and highly purified, are, however, evaluated **largely by chemical means.**

Chemical tests employed to determine the identity or purity of cellular drugs are relatively few and have already been referred to. Among such tests mention should be made of the determination of acid-insoluble ash and of crude fiber. **Chemical assays** of crude drugs also are scarce, perhaps the assay of black mustard being the only one that is strictly chemical among all of those applied to official crude drugs. The usual alkaloidal assays are extractive processes (pharmaceutical), with subsequent purification of the alkaloid. If the alkaloid be determined gravimetrically, the whole assay is pharmaceutical. If it be determined by titration, the assay does have a chemical phase. All of the other types of assays (see page 32) are strictly pharmaceutical processes except the bioassays which are pharmacological in nature.

Microchemical tests (see page 40) on crude drugs may have a chemical phase, though often not. As they require the use of the microscope for their reading, it seems desirable to include them under the microscopic evaluation of drugs.

Those drugs of plant or animal origin that are non-cellular in nature or that represent active principles from the plant (see page 33) lend

themselves more readily to chemical study. The isolation, identification, purification and characteristics as determined by tests and assays, are to some extent of a pharmaceutical nature, yet to a large extent they are chemical. The determination of the saponification value, the iodine value and the acid value of fixed oils might be mentioned as illustrations. Styrax and atropine represent typical drugs of plant origin for which extensive chemical tests have been devised.

The Physical Evaluation of Drugs

So far as crude drugs are concerned, the application of typical physical constants is very rare. Occasionally the **specific gravity** is a matter of interest, as with nutgalls, where the galls that will not sink in water are considered to be of inferior quality, and as with jalap, where its specific gravity should be higher than water. The **elasticity** of certain fibers, such as cotton, is a physical constant of importance. The reaction of certain drugs either in powdered form or on their smooth sectional surfaces, with filtered **ultra-violet light** is of importance in several cases, notably rhubarb, where the genuine Chinese Shensi rhubarb can easily be distinguished from rhapontic rhubarb by the difference in luminosity in this light. The light is also used for determining fluorescence and a play of colors in connection with certain extracts, such as chlorophyll and the extracts of certain drugs such as catechu, senna leaves, etc. Many alkaloids show distinctive colors under this light, such as aconitine (light blue), berberine (yellow), emetine (orange). An alkaloid such as quinine which shows a fluorescence in acid solution even in daylight, shows such fluorescence much stronger under the quartz lamp. Many other drugs show a marked intensity of color or characteristic color under this light.

The application of physical constants, however, is extensive in connection with certain active principles from the drugs such as alkaloids, volatile oils,

volatile oils and fixed oils), (*f*) **melting-point** (particularly of the solid fixed oils and of some alkaloids), (*g*) **water content** (as determined by drying to constant weight in an oven)

THE CHEMISTRY OF DRUGS

The living plant is nature's laboratory. Therein are synthesized not only chemical compounds that are utilized as food by man and animals (carbohydrates, proteins, fats), but also a multitude of compounds that exert a physiologic effect. It is because of these chemical compounds that drugs are used as, or are the source of therapeutic agents. *It is obvious therefore that any study of pharmacognosy must embrace* a thorough consideration of these chemical entities. The usual term for them is "constituents", but since the plant, as is true of any organism,

is composed of many chemical compounds, it is common practice to single out those compounds that are responsible for the therapeutic effect and call them "active constituents."

For purposes of classification it is logical to arrange these compounds into groups according to their constitution. It is, however, not the purpose of this introductory section to discuss each of these groups in detail. Such discussions will be found throughout the text in appropriate locations where important drugs belonging to the particular group are discussed.

1 **Carbohydrates.**—Carbohydrates are aldehyde or ketone alcohols containing carbon, hydrogen and oxygen in which the hydrogen and oxygen are in the same ratio as in water. Since carbohydrates are the first products formed in photosynthesis, they are a convenient starting point for any discussion of constituents of vegetable drugs. Moreover they are the products from which, by subsequent organic reactions the plant synthesizes a great number of other constituents. The photosynthetic reaction is expressed as follows:

$$6CO_2 \; + \; 6H_2O\,(+\,677.2\text{ cal.}) \; \rightarrow \; C_6H_{12}O_6 \; + \; 6O_2$$

When plants or animals utilize carbohydrates as food the 677.2 calories are released and the reaction of *respiration* is simply the reversal of the above. These (photosynthesis and respiration) are the most important chemical reactions with relation to the maintenance of life upon the earth.

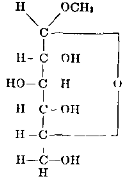
Carbohydrates are classified according to their constitution. Those having six carbon atoms ($C_6H_{12}O_6$) are called *hexoses* or *monosaccharides;* those having twelve carbon atoms ($C_{12}H_{22}O_{11}$) *disaccharides;* those having eighteen carbon atoms ($C_{18}H_{32}O_{16}$) *trisaccharides*, etc. Such simple carbohydrates, because of their solubility and sweet taste are commonly referred to as sugars (page 128). The more complex, high molecular weight polysaccharides are represented by starch (page 119), inulin (page 624) and the celluloses (page 426). These poly-
mponent hexose and are therefore
se is known as a *dextrosan*, while
Sugars and starch are important
are extensively used as foods and
pharmaceuticals

The plant also builds its structural skeleton from carbohydrate material. The name *cellulose* is given to a group of closely allied cell wall substances, having in common a portion of the molecule that is an anhydride of glucose. Other substances occur with cellulose as for example, the hemicelluloses. These
luloses but differ from cellulose in being
easily hydrolyzed. Closely related to the
mucilages (page 333) which constitute an
important group of drugs both from the pharmaceutical as well as the therapeutic viewpoint. Also associated with cellulose are the *pectins* (page 376) which have some pharmaceutical application.

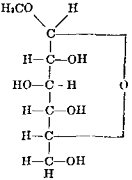
No summary of the carbohydrates is complete without mention of the pentoses and pentosans The name pentose is applied to a group of sugars having the general formula $C_5H_{10}O_5$ (arabinose, xylose, ribose) and are usually products resulting from the hydrolysis of the pentosans, of which xylan, occurring in the wood of deciduous trees, is an example. Pentoses also result from the hydrolysis of gums and mucilages.

2. **Glycosides.**—Glycosides comprise a widely distributed group of plant constituents which upon hydrolysis by enzymes or reagents yield one or more sugars among the products of the re
substance may be called a *glucoside*. S
(*i. e.*, rhamnose) frequently occur t

non-sugar portion of the glycoside is called the *aglycon*. Both *alpha* and *beta* glycosides are possible as illustrated by the formulæ for methyl glycoside:



alpha methyl glycoside



beta methyl glycoside

It is interesting to note, however, that only beta forms occur in plants. This is evidenced by the fact that emulsin and other natural enzymes hydrolyze only the beta varieties.

From a biological viewpoint glycosides play an important rôle in the life of the plant involving its regulatory, protective and sanitary functions. Among

sides from digitalis, strophanthus, squill, convallaria, apocynum, etc., laxative drugs as senna, aloe, rhubarb, cascara sagrada and frangula contain emodin

strophanthin, salicin and digitoxin, have been isolated and purified, and em-

ition is uctures classi- tuents, tannins, sterols, carotenoids, anthocyanins and many others including several whose structures are as yet unknown. A therapeutic classification, while excellent from a pharmaceutical viewpoint, omits many glycosides of pharmacognostical interest. The classification on page 309 presents an attempt at a

plant n may action is due. property of combi vtic enzymes. This acti agent action"

tract and on skin abrasions. In industry tannin-bearing plants find extensive use in the manufacture of leather and ink.

Chemically tannins are complex substances which may be classified as to whether they yield catechol or pyrogallol upon decomposition. Their rôle in plant metabolism is somewhat speculative, but they probably serve as a protective to the plant during certain stages of growth, and are finally either destroyed or deposited as end products of metabolism in certain dead tissue of the mature plant. (See pages 213 to 215.)

9. **Enzymes.**—Enzymes are organic catalysts produced by living cells. They make possible most of the chemical reactions which make up life processes. Their chemical constitution is unknown but it is believed that most of them are proteins Since they may be recovered and partially purified it would seem that they might be utilized as therapeutic agents as well as to control certain chemical reactions in industry. Pepsin, pancreatin and papain are employed therapeutically as digestants, while zymase and rennin find extensive commercial use in the fermentation and cheese industries. (See page 691.)

10. **Vitamins.**—Vitamins are organic compounds necessary to the normal growth and the maintenance of life in animals, including man. They act some- [illegible] ling food constituents. [illegible] of deficiency diseases [illegible] ble in the prophylaxis as well as the cure of these diseases. Vitamins have a wide variety of sources, both plant and animal. They are usually isolated, concentrated and purified for use as drugs. They belong to no single chemical category and vary widely as to chemical constitution. Some are related to the sterols (vitamin D), some are relatively simple (niacin), while others are quite complex. Because of their importance a considerable amount of study has been given to their chemical constitution, and some have been prepared synthetically. An extensive discussion of vitamins will be found on pages 664 to 676.

11. **Hormones.**—Hormones are the active substances secreted by the endocrine glands. They control the growth, development and metabolism of the body in various ways Like the vitamins they exhibit a variable chemical constitution. Some like ephedrine and thyroxin are simple basic compounds and amino acids, others like the pituitary and parathyroid hormones and insulin are peptid or peptone compounds, while still others like the sex hormones and those of the adrenal cortex are related to the sterols. The hormones are valuable therapeutic agents in treating conditions arising because of their natural deficiency. (See page 694.)

12. **Bacteriologics.**—This group includes a large variety of agents prepared from or by the action of bacteria and used in the prophylaxis and treatment of infective diseases. The group includes vaccines, immunogens, toxins, antitoxins and sera. Information concerning their chemistry is lacking, but they are probably protein in nature They are relatively unstable and must be kept at low temperatures. They comprise an important group of biological, therapeutic agents. (See page 66)

13. **Antibiotics.**—Certain molds and fungi synthesize compounds that are bacteriostatic and have been found exceedingly useful in treating diseases caused by bacteria and other microörganisms Representatives of the group are penicillin and streptomycin. They have received a great deal of chemical investigation and while their constitution has not been definitely established, it may soon be. They appear to be mixtures of related compounds. (See page 78.)

14. **Sterols.**—Sterols should probably be classified next to the fixed oils and fats since they occur commonly in the unsaponifiable portions of fixed oils and fats. They have, however, been placed last since many compounds classified in other groups are related to them Among these are some of the vitamins (vitamin D), the estrogens, the androgens, the adrenal cortex hormones, the digitalis aglycones, the saponin glycosides and cholesterol. The sterol nucleus is therefore an important one in the chemistry of drugs. (See page 685.)

Not all vegetable and animal drugs can as yet be classified in the above scheme, but as our knowledge of their chemistry increases their place in the arrangement will be established Since it is these chemical entities in vegetable and animal drugs that exert their physiologic action, it would seem that such a chemical arrangement would be the most logical one for the study of these drugs.

INSPECTION AND ANALYSIS OF VEGETABLE AND ANIMAL DRUGS
(Analytical Pharmacognosy)

Drugs are inspected by pharmaceutical manufacturers before purchase for economic reasons, and after purchase, to insure the high standard of the materials to be used in their products. Various state and municipal agencies also maintain laboratories for the inspection of drugs, largely in connection with their health and sanitation measures. The Food and Drug Administration operating under the Federal Security Agency conducts a nation-wide inspection service. It maintains, in addition to its principal laboratory in Washington, several District Laboratories in the major cities of the United States. These laboratories are administered as three districts, the Eastern, Central and Western. The Administration is mainly concerned with drugs in interstate commerce and with all imports into the United States. It maintains a large corps of inspectors in the field, and an additional group associated with the custom's officers at the ports of entry. Samples are taken, sealed and sent to the central laboratory at Washington or to the nearest district laboratory where they are examined by microanalysts.

As was mentioned before, the standards set forth in the monographs of the U. S. Pharmacopœia and the National Formulary comprise the legal standards for the drug In sampling, the directions of the U. S. P. and N. F. are followed. Cores are taken from bales and other bulk packages and the scheduled number of packages are taken from small-package lots.

The analyst first determines whether the sample conforms to the macroscopic and microscopic descriptions in the official monograph, noting especially the descriptive morphological features, the size, color, etc. Where necessary he
prepa
graph
or N
that
A
drug
er reduced by

ficial method.
; then boiling
weighing the
, etc , and is
an indication of the amount of dirt, soil, clay, and so on, present in the sample. It is sometimes called "foreign inorganic matter."
Moi
as well
and b
drug
determined in one of two ways. If the drug contains no volatile material, a weighed sample is heated at 100° C. to constant weight, the loss in weight being the moisture content. If, however, volatile constituents are present, these must first be determined by the volatile ether extractive method, and their weight deducted from the loss in weight upon drying, before the moisture content can be determined A second method is by means of toluene distillation,

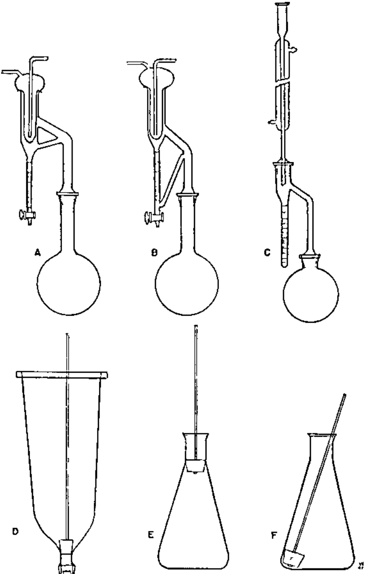


FIG 13 —*A, Clevenger apparatus for the determination of volatile oils heavier than water.*

distilled water and the pear-condenser inserted. The oil bath is maintained at a suitable temperature (125° to 135° C) to insure gentle boiling of the contents of the flask. Steam carrying the volatile oil rises through the neck of the flask, both being condensed on the surface of the pear-condenser The oil being heavier than the water sinks to the bottom of the trap and is determined volumetrically. The condensed water returns to the flask through the side-arm, the process thus being a continuous one. Between two and four hours is usually sufficient to remove all of the oil from the drug. *B, Clevenger apparatus for the determination of volatile oils lighter than water.* The flask is charged and the operation carried out as before. In this case, however, the oil floats on the water in the trap, and is again determined volumetrically. After the determination, in either case, the oil may be removed through the stop-cock at the bottom of the trap and its optical and other constants determined. *C, Toluene moisture apparatus.* The dried flask is charged with a quantity of drug that will yield between 2 and 4 cc of water. About 200 cc. of toluene are added and the trap [illegible] the trap is filled with toluene The flask is heated o[illegible]
the water being hea[illegible]
flask At the end of [illegible]
determined volumetr[illegible]
lower cork is inserted into the bottom of the stem of the percolator and the percolator

is distilled from the water being caught

Quality standards depending upon the amount of principles capable of being extracted, have been devised for certain drugs. The drug is extracted usually in a continuous extraction apparatus of the Soxhlett type, and the extract determined by weight after removal of the solvent. The common solvents used are alcohol, diluted alcohol, petroleum benzin, ether and water.

FIG 14.—Root of a rodent hair. Rodents frequently lick their fur and it is not uncommon to find hairs in the pellets. Such hair bases are identity characteristics of rat and mouse pellets. (Photograph by Paul D. Carpenter.)

The amount of volatile oil in volatile oil-containing drugs may be determined by distillation. In this method the drug is distilled with water in the proper Clevenger apparatus. This is a continuous distillation apparatus in which the separated volatile oil is caught in a trap and determined by volume. (See Fig. 13.) In an older and less accurate method the drug is extracted with ether, the solvent removed by evaporation and the moisture by desiccation, after which the volatile oil content is determined by the loss in weight upon heating to 110° C.

LEGEND OF FIG. 13.—CONTINUED

filled about two-thirds full with chloroform (sp. gr. about 1.48). The sample is then added, vigorously stirred and allowed to separate. Cereals for example will float while rodent pellets will sink into the stem of the percolator. The cork fastened to the metal rod is then inserted from above as illustrated, trapping the filth between the corks. The filth may be recovered for microscopic examination by removing the lower cork. *E, F. Wildman trap flasks for the recovery of filth by flotation.* A leaf drug, for example is placed in the flask, *F*, and boiled with water. After cooling the flask is filled nearly to the neck with water and 25 to 50 cc. of gasoline or mineral oil are vigorously stirred into the mixture using the metal rod attached to the rubber stopper as a stirring rod. After separation enough water is added to bring the oily layer into the neck of the flask. By raising the rubber stopper attached to the metal rod to the position indicated in *E*, the oily layer containing insects, insect parts, rodent hairs, etc., can be easily removed for microscopic examination. (Drawing by E. H. Wirth.)

Alkaloids are recovered from the drug material by extraction. After purification with immiscible solvents the alkaloid may be determined gravimetrically, or volumetrically by titration of the amount of acid necessary to convert it into a salt.

In a few cases, special assays for drugs containing some definite chemical constituent have been devised. In others where no chemical, physical or extractive assay is known the quality is determined by a bioassay.

After performing any additional special tests for purity or foreign matter as well as for quality, the analyst is able to prepare his report concerning the drug in relation to its conforming to the standards of the U. S. P. or N. F. monograph.

The Food and Drug Administration is very particular concerning conditions under which the drugs have been produced, transported and stored. Excessive moisture may cause decomposition and improper protection from insect or rodent attack may render the drug filthy and unfit for use. The Administration has devised special methods for the separation and identification of manure, rodent feces, rodent hairs and other filth, as well as for the separation and identification of insects. [illegible] Circular No. 1, "Microanalysis of [illegible] minute amounts are inavoidabl[illegible]ling and storage, often with the accompanying destruction of the drug. Any evidence of rodent damage such as rodent hairs, feces or urine is inexcusable and indi-[illegible]tection of the drugs. Not only is [illegible] the purely esthetic point of view; [illegible]ainly *renders* it unfit for human consumption

Insects, insect parts, rodent hairs and feces may be separated from the drug by means of liquids of varying specific gravities. [illegible] on, for example, chloroform, but rodent pellets [illegible] [illegible]l oil rises to the top [illegible]ta may be separated [illegible]eans of a percolator [illegible] 13.) The recovered impurities are then identified microscopically. Food and Drug Circular No. 1 contains several variations of these gravity separation methods applicable to specific cases and also presents several illustrations useful in identifying insects and insect parts.

The following few illustrations from the weekly reports of detentions at the Port of New York in 1946, illustrate types of frequent and common adulteration as well as the terminology used in reporting such adulteration.

Product	*Quantity*	*Reason for detention*
Juniper berries	130 bags	Filthy
Cassia	113 bags	Insect infested
Nutmegs	47 bags	Wormy and moldy
Cassia oil	10 drums	Contains rosin and heavy metals
Areca nuts	240 bags	Moldy
Aconite root	29 bags	Excess stems
Angelica root	17 bales	Excess acid-insoluble ash
Cassia oil	9 drums	Not U. S. P.
Senna leaves	96 bales	Filthy—excess foreign organic matter
Olive oil	4 drums	Rancid
Orris root	112 bags	Insect bored
Colombo root	210 bags	Wormy
Coriander seed	381 bags	Live insects
Amyris oil	1 drum	Not N. F.

Product	*Quantity*	*Reason for detention*
Cumin seed . . .	312 bags	Filthy—oil damaged
Henbane . . .	172 bales	Egyptian henbane—not the official variety
Safflower	22 bags	Rodent excreta
Digitalis	39 drums	Filthy—excess foreign organic matter
Stramonium leaves	23 bales	Manure and rodent filth
Buckthorn bark	54 bales	Not N F.
Cod oil	100 drums	Decomposed
Aconite root .	6 bags	Excess moisture
Thyme leaves	220 bags	Not official variety
Juniper berries	88 bags	Excess immature and discolored berries
Shelled almonds .	122 bags	Water damaged
Almonds (shelled)	47 bags	Dirty—excess bitter almonds
Ginger peelings .	57 bags	Valuable constituent abstracted

THE CULTIVATION OF DRUG PLANTS

The cultivation of drug plants is advantageous in that botanical source and purity can be controlled. Drugs of superior quality can be produced by breeding, control of disease, proper harvesting and drying. If operations are to be profitable a number of factors must be considered, including land and labor costs, investments in equipment and the cost of fertilizers, insecticides, seeds or planting stock, etc. The production of drug plants is a horticultural process and so involves a knowledge of propagation, cultivation, soils and the many factors affecting plant growth. Since climatic conditions vary widely and since each species has its own particular problems and habits, no more than a general outline of the principles involved can be given. It is the intention of the following discussion to present to the student such an outline so that he may have some conception of the factors involved in the cultivation of drug plants.

Propagation.—A number of plants can be grown from seed, but others are best propagated by vegetative means.

Seeds of the better-known varieties of medicinal plants are listed in the catalogs of numerous seed houses. Seeds less commonly known and not listed can usually be obtaine [illegible] more of these species. [illegible] ical names rather than [illegible] sibility of obtaining related horticultural varieties which may possess very little or no medicinal value

All seeds should be tested as to their viability and longevity by germination tests. Some seeds naturally sown at the season when they ripen will not germinate if kept until spring sowing Other seeds require a period of dormancy. [illegible] al methods, [illegible] hemicals of [illegible] ds involve [illegible] "clipping" the seed coat.

Several of the medicinal plants can be satisfactorily grown from seed sown in the field; with others because of climatic conditions or short summer seasons, sowings should be made in seed-flats or seed-pots, or in a greenhouse bench, hotbed or cold frame When plants started in this manner are placed in the

Fig. 15.—Test field of first year plants of *Hyoscyamus niger.* University of Illinois Drug Plant Experiment Station.

Fig. 16.—Test field of first year plants of *Digitalis purpurea.* University of Illinois Drug Plant Experiment Station.

field they will show an increased yield, will be able to [illegible]

FIG. 17.—Students hand cultivating sage University of Illinois Drug Plant Experiment Station

FIG. 18.—Seedlings in greenhouse benches before transfer to the field University of Illinois Drug Plant Experiment Station

heavy, soggy nor too coarse in texture. Before sowing, this soil should be thoroughly sterilized with steam or formaldehyde. If formaldehyde is used, care must be taken that the soil is well aerated before sowing as formaldehyde is very toxic to young plants. Sphagnum moss and vermiculite are also considered good for seedbeds.

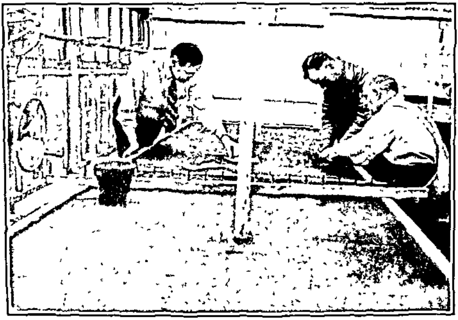


FIG. 19.—Transplanting seedlings to the greenhouse bench. University of Illinois Drug Plant Experiment Station.

FIG. 20.—Inspecting seedlings in the greenhouse bench. University of Illinois Drug Plant Experiment Station.

Depth of sowing is governed by the size of the seeds and the character of the soil. As a general rule the seed should be planted at a depth about equal to their diameter, and should be covered more deeply in a light soil than in a heavy.

The amount to be sown depends upon the germination of the seed, and the number of plants required for a given area of land. It is usually advisable to sow seed in considerable excess of the amount needed to cover unpredicted losses such as transplanting fatalities, loss from insects and disease attacks

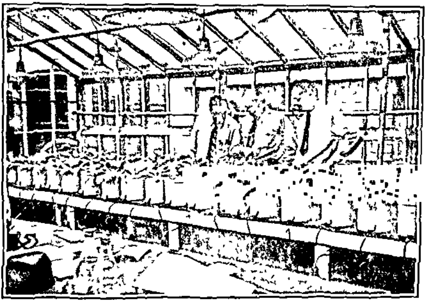


FIG 21.—Hydrophonic test with *Hyoscyamus niger* Hydrophonics offers a means of testing the nutrient factors necessary to plants University of Illinois Drug Plant Experiment Station.

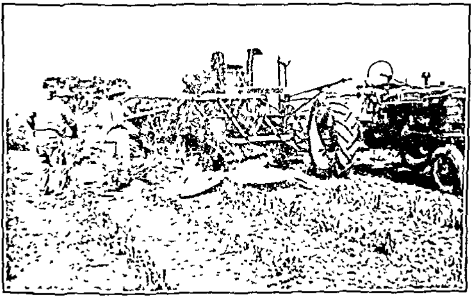


FIG 22.—Threshing caraway seed University of Illinois Drug Plant Experiment Station

Prior to sowing the seed in the open field, the soil should be specially prepared by freshly disking the plowed field, and then meeker-harrowing it until the soil is as finely subdivided as possible. The seed is preferably placed in rows with a seed drill rather than sown by hand. With the drill, the depth of sowing

is more uniform and the soil is compacted over the seeds, thus favoring better germination. The distance between the rows depends upon the size of plants at maturity and the method of cultivation to be used. Eighteen inches to three feet is the common range.

Fig. 23 —Damage to young plant of *Hyoscyamus niger* by the Colorado potato beetle University of Illinois Drug Plant Experiment Station.

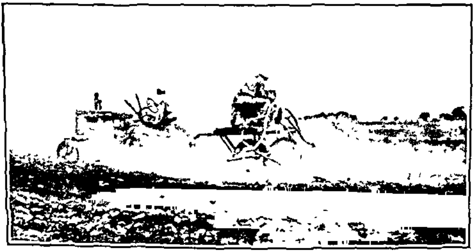


Fig. 24 —Dusting with rotenone dust to control the Colorado potato beetle. University of Illinois Drug Plant Experiment Station.

When the seedlings have reached a height of 1 inch or more and have pro-
duced one or tw
is a severe shock
is loosened and r
moisture which
should therefore
reestablish its r
cool, cloudy or
chances for recovery.

The plants may be transferred into regular clay pots, the ordinary paper pot, into regular flats, or placed directly into the soil of the greenhouse benches The regular flats are shallow wooden boxes, 3 inches deep, 12 to 14 inches in width and 14 to 18 inches long. The seedlings when placed in either the flats or greenhouse bench are spaced in rows, about $2\frac{1}{2}$ or 3 inches apart each way. When individual plants have more space they develop stocky and healthy overground parts and also better root systems. These plants will be better

to the field. The soil into which these plants

eviously sterilized, and it should be rich and of

ter as that in the field to which they will be

Plants may be transferred to the field as soon as they can be safely grown out of doors. Some may be placed in the field at an earlier date than others because of their natural hardiness toward cold weather or frosts. The requirements and necessary care for each plant are best determined by experience and observing the growth habits of each.

Prior to field planting, the soil must be well prepared by proper plowing either in the fall or spring, followed by repeated disking and meeker-harrowing until all soil particles are finely subdivided. If it is only a small area of about an acre or two, it may be properly prepared by using a roto-tiller. If the soil

quent in ... ates the soil. A ... son

The p ... These barriers ... d dusts. Chemicals such as arsenic or other known harmful substances cannot be used because they will adhere to the plant and be carried over into the drug or its preparations.

Vegetative propagation consists of the production of a complete plant from a bud. Asexual reproduction of plants differs from sexual reproduction in that vegetative plant parts such as stems, roots, bulbs and leaves are used rather than seeds. It is a method whereby varieties may be reproduced and preserved indefinitely and is a process of isolating superior strains of varieties and preserving them true to type. The methods by which plants may be reproduced

The particular process

the plant to be repro-

in any basic respect

and the simplest method that

which has a number of aerial stems or buds into separate parts each having roots and a growing point. In division they do not naturally break apart but may be cut or torn from the plant before rooting. Some parts often detach themselves into new plants, such as bulbs and corms.

Layerage is used in the

when grown from seed; t

may be used, and also for

leaves do not root easily

rooting by bending the stem until its tip touches the ground and then covering the tip with a little soil. It begins to thicken, take root and establish a new plant. Stems that form roots while still attached to the parent plant are called layers. When long shoots are alternately covered and exposed over their entire length the process is known as compound layerage. An advantage of layerage is that it does not require the close attention required by cuttings and the disadvantages are, that it is a slow and cumbersome method of propagation and may interfere with cultivation.

Cuttage is the process of propagation using such plant parts as roots, rhizomes, tubers, stems or leaves, which are cut in pieces with or without buds. These pieces take root and asexually produce new plants of the same variety and species as the parent plant. It differs from layerage in that the parts used are detached from the parent plant before they have an opportunity to develop roots. Propagation by cuttings is a cheap, convenient and popular method to secure new plants. A fully developed and often stronger plant is obtained in less time than when seed is sown, and the character of the variety is preserved in the new plant.

Graftage is the art of inserting a part of one plant into another plant usually different but closely related, in such a way that the two will unite and continue to grow together The rooted plant is called the stock and the portion cut off is the scion or graft. It differs from cuttage, layerage and bulb propagation in that the plant part expected to produce the top of the new plant is deprived of its own root system and unites with another plant that supplies this part. Graftage is a means of preserving and perpetuating some varieties that cannot be reproduced easily by other vegetative methods and it is also used to alter certain plant characters

The requirements and necessary care toward plants produced by one of the above vegetative processes is the same as for any plant grown from seed. The same cultural practices such as transplanting and cultivation preparations are observed

Factors Affecting Cultivation.—From the time the plant is placed in the field until it is harvested, a number of factors may favorably or unfavorably affect its growth Climate, soil, management of the soil, fertilizers and plant disorders are a few of the important factors to be observed and considered.

Climate.—Plant growth is definitely affected by climate All of the climatic factors are interrelated whereby an excess or a deficiency in one factor may limit the effect of the other factors of climate.

Conditions of temperature that are the most favorable for growth of one kind of plant or for one growth process may not be most favorable for that of some other plant or growth process. Minimum and maximum temperatures that a plant will endure may be much lower or higher than that which another will tolerate. Different parts of the same plant vary greatly in the temperature that they w[illegible] ion of maturity. [illegible] owing area and lik[illegible] withstand at different stages of growth.

Classification of crop plants is based upon temperature relations and are most commonly divided into temperate, subtropical and tropical zones. Temperature also regulates the length of growing seasons, and indirectly influences the prevalence of insects, fungi, bacteria and other parasites. It is possible for the grower to make many adjustments to temperature conditions through various cultural practices such as providing natural or artificial protection for the plants when necessary, selection of type and variety of plant adaptable to the growing area, and many other thoughtful considerations beneficial to the plant.

Water is the second important factor in plant growth. Since the amount of [illegible] er to the plant, [illegible] given climatic [illegible] pply by certain

cultural practices such as cultivation and mulching plus principles of soil conservation.

Velocity of the wind influences evaporation of moisture from the soil, the strength of the plant, and in many cases flower fertilization. In some cases wind protection is necessary and is afforded by planting shelter beds or wind rows for the benefit of other plants.

Plants vary in the amount and intensity of light which they require In certain cases light governs the amount of the principal constituent produced in the plant. Intensity of light ar
plants to flower and reproduce.
able to its light requirements an
plied when cultivating that same plant.

Altitude directly or indirectly affects the presence of constituents in many plants. Some plants grow very luxuriantly at low levels but have no medicinal value unless grown at high elevations Other medicinal plants are most adaptable to near-sea levels.

Soil is the product resulting from the various stages of disintegration and decay of rocks and plant and animal materials, in which plants can grow The resulting product varies widely in physical, chemical and biological characteristics and consequently in its ability to support plant growth.

Physical Condition of the Soil.—The physical condition of the soil is determined by texture and structure. Texture refers to the size of the individual
oil particles within
groups which are

Coarse gravel rock	more than 20 mm.
Fine gravel	20–2 mm.
Coarse sand	2–0 2 mm.
Fine sand	0 2–0 02 mm.
Coarse clay or silt	0.02–0 002 mm.
Fine clay or colloidal clay	less than 0 002 mm.

Class names such as sandy loam, loam, silt loam and clay give some idea of the textural make-up and structure of soils. Each class contains various proportions of different-sized particles.

	Per cent sand	*Per cent silt*	*Per cent clay*
Sandy loam	75	14	11
Loam	32	45	23
Silt loam	5	82	13
Clay	10	45	45

ed soil
Loam
hile the
ages in
porosity.

Soil Fertility.—Fertility of the soil is an indication of its ability to support plant life when provided with th

the fertility. Factors affecting
soil texture
organic
amount
are very

suitable soil conditions for plant growth. There is a direct and marked [illegible]

[illegible]

the influence of necessary tillage practices to control soil erosion. The position of the soil, that is, its aspect and elevation affects the temperature, water supply, the composition, the soil reaction and the content of soluble matter.

Soil Management.—Proper management of the soil is an intricate problem and therefore when judiciously exercised, it will favorably affect the cultivation of medicinal plants. The principal objects are to provide a favorable moisture supply; to supply sufficient nutrients for optimum growth and production; to add enough organic matter to offset that lost by decomposition, by organisms and by erosion, to prevent erosion; and to avoid injurious compacting of the soil. A good system of soil management which will satisfy these objectives includes five major features. The first of these is good tilth whereby plowing and cultivation conditions the soil physically for proper moisture, drainage and aeration requirements. Control of weeds is closely associated with good tilth. Third, plant diseases and insect pests are controlled by handling the soil in various ways. Fourth, a proper rotation of crops influences the soil physically, chemically and biologically. The fifth major requisite is to provide adequate supply of available plant nutrients by the use of good tilth practices, or by the application of fertilizers.

The primary interest of soil management is to maintain soil productivity and to commercially produce satisfactory plants and plant products at a minimum cost.

Fertilizers.—The use of fertilizers may favorably affect the production of vegetable drugs in quantity and quality. Soils in which plants grow are not alike in fertility while the plants themselves are not alike in their need for and use of nutrients in the soil. Sometimes fertilization is necessary and profitable but it can be definitely unnecessary and unprofitable at other times. Addition of plant nut[illegible] present rather than [illegible] a commercial ferti[illegible] between the necessary elements of nutrition. This balance is important in order to avoid an under- or overstimulation of the plants. Another factor to consider when applying commercial fertilizers is the amount of plant nutrients consumed by many of the soil microorganisms

Nitrogen, phosphorus and potassium are often referred to as the fertilizer elements. Other elements of lesser importance are calcium, magnesium, sodium, iron, manganese, boron, copper, zinc, cobalt, molybdenum and aluminum. These are occasionally applied when certain plants by their symptoms demonstrate specific deficiencies of one or several of these elements.

[illegible]-product is a valuable fertilizer It [illegible] m[illegible] content of the soil

It is best to first determine the fertilizer needs and then exercise special care in the purchase and application of commercial fertilizers. Their misuse will quickly affect plant growth.

Plant Disorders.—Plants should be protected from all possible injury, in order to be productive. Any disorder, whether it be caused by insects, fungi, bacteria, viruses or because of some unfavorable environmental factor incapacitates a plant. In order to minimize the losses it is important to be on the watch for these disorders and injuries, to immediately ascertain the cause and apply the most efficacious remedial control measure.

When possible select an insecticide or a fungicide most specific for the parasite. Choose such agents that will not be poisonous to humans because they may be easily carried on the overground parts and found in the finished drug products.

Constitutional or physiological disorders due to environmental factors may be remedied by recognizing the cause and correcting the detrimental factor or factors. Many of the mechanical injuries such as bruises tend to heal over,

[illegible]

specifically resistant and immune to disease Another method is to introduce competitive insects, fungi and bacteria that are harmless to plants but will destroy the detrimental organisms. In some cases a change in environment for the growing of certain plants would naturally control the attacks by plant pests because their growth and development depends upon a limited range of environmental factors

THALLOPHYTA OR THALLOPHYTES

THE thallophytes comprise about 100,000 species of algæ, fungi and lichens, yet relatively few are at present of economic importance. The algæ are chiefly used as a source of iodine and for the mucilage that they contain, such as algin, carageenin and agar. A number of lichens yield important coloring matters used in pharmacy. Some of the fungi produce important medicinal agents, such as the antibiotics; others cause diseases in plants, animals and man.

SCHIZOMYCETES OR BACTERIA

The bacteria have been included in the past with the fungi, but now are generally considered as a separate group possessing both animal and plant characteristics. Hence, these organisms may be regarded as a connecting link between plants and animals.

Bacteria are non-chlorophyll-bearing, unicellular organisms, rarely more than 25 by 3.5 microns in size and may be as small as 0.5 by 0.2 microns. They possess an abundance of nuclear material but no true nuclei, and generally divide by transverse fission (*schizo* means to cleave or split; *myces* refers to fungus). In shape they vary from perfect spheres to greatly elongated rods, sometimes curved. Some rod-shaped species are motile by means of flagella, and some produce very resistant structures known as endospores. Of the several thousand species of bacteria, only a few have the power to infect animals or plants and thus produce disease.

Certain biological preparations of bacteria and of molds are valuable as specific cures for certain diseases or in prophylaxis and diagnosis. The production of these preparations requires special facilities and special care to prevent contamination, hence their manufacture is permitted only under government license and inspection. These products may be classed as Vaccines, Tuberculins, Toxins, Antitoxic Serums, Antibacterial Serums, Antibiotic Agents, etc.

These preparations should be preserved at a temperature between 2° and 10°C, preferably at the lower limit. They should be dispensed in the unopened glass containers in which they were placed by the manufacturers. To provide for a certain degree of deterioration, manufacturers package a product of higher potency than is stated on the label, and place a limiting date on the label after which the potency of the product is not guaranteed.

VACCINES

Vaccines contain attenuated or modified viruses, killed rickettsiæ or attenuated or killed pathogenic microorganisms (antibacterial vaccines), and are to be used as an inoculation to stimulate the production of

antibodies, and thereby an immunity against the disease in its more virulent form. The general action of vaccines is therefore preventive (prophylactic). Some are used, however, as therapeutic agents.

The attenuation of viruses, or of pathogenic bacteria, so that they may be injected into the animal body without danger of producing serious pathological conditions, may be accomplished by one of the following methods: passage through some species other than the animal for which the infection is specific (smallpox vaccine); drying at constant temperature (rabies vaccine, Pasteur); growth at a temperature above the optimum (blackleg vaccine, anthrax vaccine); heating at a relatively high temperature (blackleg vaccine); and treatment with chemicals (anthrax vaccine).

Rabies Vaccine, Antirabic Vaccine or Pasteur Treatment (U. S. P. 1936 to date) is an uncontaminated suspension of the attenuated, diluted, dried or dead, fixed virus of rabies. The virus is contained in the tissue of the central nervous system of an animal suffering from fixed virus rabies infection.

This vaccine is solely for preventing development of rabies in persons bitten by an animal supposed or known to be rabid, and to be effective it should be administered as soon as possible after the wound has been inflicted. With the living vaccine, [illegible]
so until the last [illegible]
up to a total of [illegible]
the patient against the disease

Smallpox Vaccine, Glycerinated Vaccine Virus, Jennerian Vaccine (U. S. P. 1916 to date) consists of a glycerinated suspension of the vesicles of vaccinia or cowpox which have been obtained from healthy vaccinated animals of the bovine species. The vesicles must be removed and the vaccine must be prepared under aseptic conditions.

The vesicles must be removed from the animal at the time of maximum potency, thoroughly triturated and made into a smooth suspension with an aqueous solution of glycerin. This solution shall not be acid to bromcresol purple T.S. and not distinctly alkaline to phenol red T.S.

Smallpox vaccine is used as a prophylactic before infection with smallpox occurs. A very small quantity of the vaccine is inoculated into the scarified skin and a mild form of the disease results.

The immunity thus acquired is active and is usually of long duration, but it gradually diminishes. Seven years may be taken as the average period of fairly complete protection; then revaccination should be made.

Yellow Fever Vaccine (U. S. P. 1947 to date) consists of a living culture of an attenuated strain of yellow fever virus, selected for high antigenic activity and safety. It is prepared by culturing the virus in the living embryo of the domestic fowl (*Gallus domesticus*). The resulting culture after appropriate processing is distributed in suitable quantities into ampules and dried from the frozen state, after which the ampules are filled with dry nitrogen and hermetically sealed. The vaccine is rehydrated immediately before use. Yellow fever vaccine shall not contain human serum because of a certain icterogenic factor it contains.

Millions of American military personnel have been protected from yellow fever by this vaccine, which is highly satisfactory.

Influenza Virus Vaccine, Types A and B, are made from concentrated virus in allantoic fluid, rendered non-infective by the addition of formaldehyde in 1 to 5000 dilution and given subcutaneously in a single dose of 1 cc.

The vaccine tested in human subjects provided protection to approximately 75 per cent of those vaccinated. The duration of immunity is not fully established, and a repeat dose of 1 cc. at three-month intervals during the influenza season is suggested.

Encephalitis Vaccine, Herpes "F" Strain (Formalin-killed).—Levaditi and Harvier isolated from patients su [illegible] of herpes virus which was capable o [illegible] er, the etiology of the disease is not [illegible]

This vaccine is recommended as an aid in the treatment of both the acute and chronic stages of encephalitis.

Encephalitis Vaccine, Japanese Type B, is a formalin-inactivated vaccine prepared from the virus grown on the allantois of the developing chick embryo. A considerable amount of this vaccine was used to immunize members of the United States armed forces.

Equine Encephalomyelitis Vaccine, Eastern Strain and Western Strain, are prepared from formalized chick-embryo cultures and are recommended for the immunization of horses and humans.

Bacterial vaccines or bacterins consist of dead specific bacteria. Suspensions of young, living cultures are killed chemically or by the application of moist heat at a temperature slightly above their thermal death-point. Wright and Douglas first advanced the theory of opsonic action and suggested that the subcutaneous injection of a given species of dead bacteria conferred to the treated individual greater opsonic activity towards the species of organism in question. An opsonin is apparently an antibody in the serum acting upon the invading organisms so as to prepare them for more ready ingestion by the phagocytes. Other antibodies also may have a part in the immunity induced by the injection of these dead organisms.

Bacterial vaccines may be **autogenous,** that is, prepared from a culture of the specific organism isolated from the patient in question; or may be **stock vaccines** prepared from specific organisms that have been cultured in the laboratory for some time

Some of the more common stock vaccines are the following: Typhoid, Typhoid-Paratyphoid, Cholera, Plague, Acne Combined; Catarrhalis Combined (Respiratory); Coli Combined (VanCott's); Gonococcus; Influenza Combined; Pertussis (Sauer); Pertussis [illegible] cus Combined; Staphylococcus; Staphylococc [illegible] treptoccus Erysipelatus and Bacillus Prodig [illegible] Streptococcus-Staphylococcus, Undulant Fever

A number of bacterial vaccines also are prepared for veterinary use.

Typhoid Vaccine, Typhoid Bacterial Vaccine, Typhoid Prophylactic, or Enteric Vaccine (U. S. P. 1936 to date) is a sterile suspension in isotonic sodium chloride solution or other suitable diluent of killed typhoid bacilli. The vaccine shall contain in each cubic centimeter at least 1,000 million typhoid organisms.

Typhoid vaccine is used largely as a prophylactic inoculation to actively immunize against typhoid fever. Three doses are given subcutaneously with

an interval of about one week between successive doses; the first dose is 0.5 cc., and the following doses each 1 cc.

Typhoid and Paratyphoid Vaccine, Typhoid Combined Vaccine, or Mixed Enteric Vaccine (U. S. P. 1936 to date) is a suspension in isotonic sodium chloride solution or other suitable diluent of killed typhoid bacilli (*Eberthella typhosa*) and killed paratyphoid "A" bacilli (*Salmonella paratyphi*) and killed paratyphoid "B" bacilli (*Salmonella schottmülleri*). The vaccine shall contain, in each cubic centimeter, at least 1,000 million typhoid organisms and at least 250 million each of the paratyphoid organisms.

The uses and the doses are the same as for typhoid vaccine.

Cholera Vaccine, Cholera Bacterial Vaccine, or Cholera Prophylactic Vaccine (U. S. P. 1946 to date) is a sterile suspension in isotonic sodium chloride solution or other suitable diluent, of killed cholera vibrios (*Vibrio comma*) of strains selected for high antigenic efficiency. The vaccine shall contain, in each cubic centimeter, at least 8,000 million cholera organisms

Two subcutaneous injections of cholera vaccine are given with an interval of seven to ten days between the injections The first dose is 0.5 cc. and the second dose is 1 cc.

While statistically the results reported on cholera vaccination leave much to be desired, it is considered sufficiently protective to assure enough reduction in morbidity and mortality from cholera to warrant its use.

Plague Vaccine, Plague Bacterial Vaccine, or Plague Prophylactic Vaccine (U S. P. 1946 to date) is a sterile suspension in isotonic sodium chloride solution or other suitable diluent, of killed plague bacilli (*Pasteurella pestis*) of a strain selected for high antigenic efficiency. Plague vaccine shall contain, in each cubic centimeter, at least 2,000 million plague organisms.

Two subcutaneous doses are given with an interval of ten days between the two doses. The first dose is 0.5 cc and the second dose is 1 cc.

The results of vaccination against plague have not been easy to evaluate because of the difficulties in obtaining reliable statistics Probably both the attack rate and the death rate may be reduced by vaccination.

The *Rickettsiæ* form a rather arbitrary group of microorganisms which inhabit the tissues of insects (Arthropods); they live and multiply only within the cytoplasm of living cells.

Exanthematic Typhus Vaccine (U. S. P. 1947 to date) is a sterile suspension of the killed organisms of a strain or strains of epidemic typhus rickettsia (*R. prowazeki*) selected for antigenic efficiency.

The rickettsial organisms are obtained by culturing in the yolk sac membrane of the developing chick embryo (Cox Method) The initial vaccination consists of three injections of 1 cc. each, administered intracutaneously with intervals of from seven to ten days between injections The prophylactic use of typhus vaccine in typhus-infected countries is believed to be of value in preventing the disease

Rocky Mountain Spotted Fever Vaccine is a phenol-killed suspension of rickettsia prepared from the tissues of Rocky Mountain wood ticks, or the

yolk sac, infected with *Rickettsia rickettsii*
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Immunogens.—Immunogens are prepared by extracting live organisms with physiological salt solution immediately on removal from the culture medium on which they have grown. Therefore, they consist mainly of products derived from the ectoplasm of the bacterial cells and are specific in their action.

When immunogens are compared by laboratory tests with other antigens, the antibody content of the serum of animals immunized with immunogens always shows the highest antigenic titration.

Immunogens can be used for the same class of cases as bacterial vaccines and clinical results show there are more rapid and intense antigenic effect from them than from bacterial vaccines and they can be safely administered and well tolerated by the patients.

More commonly used immunogens are. Catarrhalis Combined; VanCott's Immunogen Combined, Influenza-Pneumonia Combined; Pertussis; Pneumococcus; Staphylococcus; Streptococcus Combined; Streptococcus (Arthritis).

Bacteriophage.—In 1915 Twort reported a curious degenerative change *that he observed during his work with glycerinated calf vaccinia.* In 1916–17 d'Herelle published his first work on the lytic principles of filtrates of broth cultures from feces of dysentery patients. d'Herelle named the principle responsible for the lytic action, "Bacteriophage." It is widely accepted that both Twort and d'Herelle described the same phenomenon.

d'Herelle has described the lytic principle as a living, ultra-microscopic organism parasitic upon bacteria, a complete dissolution of the bacterial cell taking place. Studies using the electron microscope have shown some phages to possess rounded and others cubical forms. Some of these organisms apparently have a flagellum. Bacteriophage can be propagated through an unlimited series of bacterial cultures provided they are young, actively multiplying and susceptible. The phenomenon of bacteriophage is twofold—a dissolution of the bacterial cell takes place and in the course of this the bacteriophage principle reproduces itself.

Bacteriophage may be isolated from several different sources. It has been shown to be present in the intestinal contents of normal man and animals, in the blood, urine and pus of those who are convalescents from bacterial infections, and in sewage water. It is also occasionally found in old laboratory cultures.

Bacteriophage is not, as a rule, strictly specific for a given species ... ainst closely ... It has been ... he antigenic structure of the bacteria.

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Since [illegible] of susceptible bacteria in [illegible] is directly involved in recov[illegible]nical reports of bacteriophage therapy indicates that it is very useful in staphylococcus, streptococcus and non-specific urinary infections and to a certain extent in enteric infections.

The principal commercial forms are as follows: Staph-bacteriophage, Strept-bacteriophage, Coli bacteriophage, Staph-coli bacteriophage.

TUBERCULINS

Tuberculins are preparations made in a number of ways from the human and bovine strains of the tubercle bacillus and are used both in diagnosis and treatment. The active substance of the tuberculin, which is apparently an albuminous derivative insoluble in alcohol, is elaborated by the organisms during their multiplication. In human, as well as in veterinary practice, tuberculin may be applied as a diagnostic agent to determine whether the person or animal is or has been infected with mycobacterium. The tuberculin may be applied by intracutaneous injection, by rubbing into the scarified skin, by dropping into the eye, or by other methods. In each case a marked redness or inflammation indicates a positive reaction.

Tuberculin must be capable of effecting a general and local response in tuberculous guinea-pigs.

Tuberculin is used mostly as a diagnostic agent, but also sometimes as a curative agent. Average dose, by intracutaneous injection, 0.001 cc.

TOXINS, TOXOIDS AND VENINS

Toxins are antigens that have the power of stimulating certain cells of the animal body to produce antitoxins.

Endotoxins are present in the bacterial vaccines (page 66) and refer to toxins which do not diffuse out of the intact bacterial cells.

Endotoxins are soluble toxins and diffuse out of the intact bacterial cells. To produce commerciel exotoxins, the highly virulent organisms are cultured in bouillon and killed with an antiseptic; the product is then filtered to produce the dead organisms and standardized upon a suitable animal for the minimum lethal dose. As commercial toxins are essential for the production of antitoxins, at least as many are produced as there are antitoxins (see pages 74 to 76).

Some plants also produce toxins (ricin, abrin, etc), though these are of the endotoxic type.

Old Tuberculin, Tuberculin-Koch, Concentrated Tuberculin, Crude Tuberculin (U. S. P. 1936 to date) is a sterile solution in a special liquid culture medium of the soluble products of growth of the tubercle bacillus (*Mycobacterium tuberculosis*), and should contain about 50 per cent of glycerin.

Purified Protein Derivative of Tuberculin (U. S. P. 1947 to date) is a sterile soluble product of the growth of the tubercle bacillus (*Mycobacterium tuberculosis*) prepared in a special liquid medium free from protein.

As an agent for the diagnosis of tuberculosis it has the distinct advantage of being a practically pure specific tubercle protein, and free from residual constituents of the synthetic medium in which the product is developed.

chick embryo type prepared from the yolk sac, infected with *Rickettsia rickettsii* (*Dermacentroxenus rickettsii*). The protective value is definite but the degree of protection varies with individuals.

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Since bacteriophage brings about complete dissolution of susceptible bacteria in the test-tube, d'Herelle believes that bacteriophagy is directly involved in recovery from infectious diseases. A review of the clinical reports of bacteriophage therapy indicates that it is very useful in staphylococcus, streptococcus and non-specific urinary infections and to a certain extent in enteric infections.

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To produce commercial **Exotoxins**, the highly virulent organisms are cultured in bouillon and killed with an antiseptic; the product is then filtered to remove the dead organisms and standardized upon a suitable animal for the minimum lethal dose. This dose is the smallest amount of the toxin that will cause the death of a guinea-pig (weighing between 250 and 280 gm.) within ninety-six hours after subcutaneous administration. As commercial toxins are essential for the production of antitoxins, at least as many are produced as there are antitoxins (see pages 74 to 76).

Toxoids are modified toxins in which the toxic powers are greatly reduced, but the ability to induce active immunity remains.

Venins are similar to exotoxins, but are produced by animals (snakes, toads, scorpions, etc.).

Snake Venins are obtained by irritating poisonous snakes, held facing a sheet of paper tied over a conical glass container. The snake "strikes" the paper, which is penetrated by its fangs, and the semi-liquid "poison" is ejected into the glass container or retained on the inner side of the paper. Mixtures of venins from the poisonous snakes of a locality, country or continent are prepared and used for the preparation of polyvalent antivenins.

The **Fer-de-Lance Venom Solution** is
tion to bleeding areas. The **Moccasin Ve**
hypodermically for the control of certai

Poisonous snakes of North America include rattlesnakes, coral snakes, copperheads and water moccasins; those of Central and South America include the bushmaster, Fer-de-lance, tropical rattlers and palm vipers; those of Africa include the boomslang, cobras, mambas, puff adder and gaboon viper; those of India include the cobras, kraits and sea snakes of the Indian Ocean.

Diagnostic Diphtheria Toxin, Schick Test Toxin (U. S. P. 1936 to date) is a sterile solution of the toxic products of growth of the diphtheria bacillus (*Corynebacterium diphtheriæ*).

This toxin is used to determine the antitoxic power of the patient. If the patient possesses a fair degree of immunity against diphtherial infection, the toxin used will cause no irritation or redness, for its toxic powers have been overcome by the antitoxin present in the serum or plasma of the patient. If

Scarlet Fever Streptococcus Toxin, Dick Test Toxin (U. S. P. 1936 to date) is a sterile solution in a medium containing not more than 1 per cent of peptone but no meat extractives, of certain products, including a soluble toxin, resulting from the growth in the broth of suitable strains of hemolytic streptococci (*Streptococcus scarlatinæ*).

The potency of the toxin shall be expressed in terms of the skin test dose, which is the smallest quantity of toxin, injected intracutaneously, that will give positive reactions in any person susceptible to scarlet fever, and negative reactions in any person immune to scarlet fever.

Average intracutaneous dose for determining susceptibility (Dick Test) is 0 1 cc. of the dilution, representing one skin test dose; for prophylactic use graded hypodermic doses are given at proper intervals until a negative Dick Test is obtained.

Diphtheria Toxoid, Diphtheria Anatoxin or Anatoxin-Ramon (U. S. P. 1936 to date) is a sterile aqueous solution of the products of growth of the diphtheria bacillus (*Corynebacterium diphtheriæ*) so modified by special treatment as to have lost the ability to cause toxic effects in guinea-pigs but retaining the property of inducing active immunity. The toxicity of diphtheria toxoid shall be so low that five times the dose for the adult human does not cause either local or general symptoms of diphtheria poisoning in a guinea-pig within thirty days after its injection into the animal. The antigenic value shall be such that the initial dose for humans shall protect at least 80 per cent of guinea-pigs, six weeks after injection, against five minimum lethal doses each of diphtheria test toxin.

Diphtheria toxoid, when administered subcutaneously, acts as an antigen,
roduce antitoxin, thus immunizing
hypodermic, for active immuniza-
the label), to be repeated twice at
intervals of approximately three weeks between injections

Alum-precipitated Diphtheria Toxoid (U. S. P. 1942 to date) is a sterile suspension of diphtheria toxoid precipitated with alum from the solution in which the products of growth of the diphtheria bacillus (*Corynebacterium diphtheriæ*) have developed and have been so modified by special treatment as to have lost the ability to cause toxic effects in guinea-pigs, but retaining the property of inducing active immunity.

After injection, alum-precipitated toxoid is slowly absorbed, thus acting as
m of the body.
patients reac-
cc. each with
an interval of one week

Tetanus Toxoid (U S. P. 1942 to date) is a sterile solution of the products of growth of the tetanus bacillus (*Clostridium tetani*), so modified by special treatment as to have lost the ability to cause toxic effects in guinea-pigs, but retaining the property of inducing active immunity.

Average prophylactic dose: 0 5 cc or 1 cc. to be repeated at an interval of approximately three weeks.

Alum-precipitated Tetanus Toxoid, Refined Tetanus Toxoid (U. S. P. 1942 to date) is a sterile suspension of tetanus toxoid, precipitated with alum from a solution in which the products of growth of the tetanus bacillus (*Clostridium tetani*) have developed and have been so modified by special treatment as to have lost the ability to cause toxic effects in guinea-pigs but retaining the property of inducing active immunity.

Average dose: hypodermic for active immunization, 1 cc. (or 0.5 cc.), to be repeated once with an interval of four to six weeks.

ANTITOXINS AND ANTIVENINS

Antitoxins or Antitoxic Serums are prepared from the blood of horses which have been immunized by repeated injections of specific bacterial toxins. The toxin, in constantly increasing doses, induces the formation of antitoxin in great excess which appears in the blood serum of the injected animal. The animal is bled, the clot permitted to form and the clear supernatant serum separated for use, or the globulins bearing the antitoxic substance are "salted out." Antitoxins in the dried globulins can be preserved indefinitely.

The following commercial antitoxins are produced: Diphtheria, Tetanus, Gas Gangrene (Perfringens), Botulinus, Scarlet Fever.

Antivenins are prepared in the same manner as antitoxins and possess the same general characteristics. North American, South American and African polyvalent antivenins and several univalent forms are commercially produced.

Diphtheria Antitoxin, Purified Antidiphtheric Serum, or Antidiphtheric Globulins (U. S. P. 1905 to date) is a sterile solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against diphtheria toxin.

After the serum or plasma from the immunized animal has been collected, the antitoxin-bearing globulins are separated from the other constituents of the serum or plasma and dissolved in freshly distilled water. Sodium chloride and a preservative are then added and the solution is filtered through a bacteria-excluding filter. Diphtheria antitoxin has a potency of not less than 500 antitoxic units per cubic centimeter.

The antitoxic unit is the amount of diphtheria antitoxin necessary to prevent the death of a guinea-pig, weighing between 250 and 280 gm. when injected with 100 minimum lethal doses of the same lot of toxin used to stimulate the production of the antitoxin. Average therapeutic dose by parenteral injection, 20,000 units; prophylactic dose, 1,000 units.

Antitoxins and antivenins give a valuable passive immunity when injected [illegible]

[illegible]

from the coagulated blood of a horse, immunized through the inoculation of diphtheria toxin The therapeutic dose was 3,000 units and the prophylactic dose 500 units. This preparation has been deleted and is no longer used. Sensitization of patients to horse-serum proteins, which frequently occurred, gave rise to serious complications.

Dried Diphtheria Antitoxin of U. S. P. 1916 to 1926 was obtained by the [illegible] toxin in a vacuum [illegible] ver it a current of [illegible] was 10,000 units [illegible] deleted from the Pharmacopoeia largely because of the difficulty experienced by physicians in preparing suitable solutions of the dried serum without contamination with air-borne bacteria.

Scarlet Fever Streptococcus Antitoxin, Scarlet Fever Antitoxin or Anti-Scarlet Fever Globulins (U. S. P. 1936 to date) is a sterile solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against the toxin produced by the streptococcus regarded as causative of scarlet fever. The potency of this antitoxin is not less than 400 antitoxic units per cubic centimeter. Average therapeutic dose by parenteral injection, 6,000 units; prophylactic dose, 2,000 units. The diagnostic dose for aid in determining the nature of a rash (Schultz-Charlton Test), intracutaneous into erythematous eruptions, is not to exceed 0.2 cc.

Tetanus Antitoxin, Purified Antitetanic Serum, Antitetanic Globulins (U. S. P. 1916 to date) is a sterile solution of antitoxic substances obtained from the blood serum or plasma of a healthy animal which has been immunized against tetanus toxin. It has a potency of not less than 400 antitoxic units per cubic centimeter. The method of preparation is the same as for diphtheria antitoxin. Average therapeutic dose by parenteral injection is 20,000 units; prophylactic dose is 1,500 units.

Tetanus Antitoxin (U S P. 1916 to 1926) was a fluid, having a potency of not less than 100 units per cubic centimeter, separated from the coagulated blood of the horse or other large domestic animal, which has been properly immunized against tetanus toxin The average therapeutic dose was 10,000 units and the prophylactic dose 1,500 units. This preparation is no longer used because of the possibility of sensitization of the patient to horse serum.

Dried Tetanus Antitoxin (U S. P 1916 to 1926), prepared in the same manner as Dried Diphtheria Antitoxin, has been discontinued in medical practice because of the danger of bacterial contamination in the preparation for injection.

Tetanus and Gas Gangrene Antitoxin (U. S. P. 1947 to date) is a sterile solution of antitoxic substances obtained from the blood of healthy animals immunized against the toxins of *Clostridium tetani* and *C. perfringens* and *C septicum* Each package contains not less than 1,500 units of tetanus antitoxin and not less than 2,000 units of each of the other component antitoxins. The average parenteral dose as a prophylactic is the contents of one or more packages.

Bivalent Gas Gangrene Antitoxin (U. S. P. 1947 to date) is a sterile solution of antitoxic substances obtained from the blood of healthy animals, which have been immunized against *Clostridium perfringens* and *Clostridium septicum* toxins. Each package of bivalent gas gangrene antitoxin shall contain not less than 10,000 antitoxic units of each of the component antitoxins.

Trivalent Gas Gangrene Antitoxin (U. S. P. 1947 to date) is a sterile solution of antitoxic substances obtained from the blood of healthy animals which have been immunized against the toxins of *Clostridium perfringens*, *Clostridium septicum* and *Clostridium oedematiens* (Novyi). Each package of trivalent gas gangrene antitoxin shall contain not less than 10,000 units of *Clostridium perfringens* and *Clostridium septicum* antitoxins, and 1,500 units of *Clostridium oedematiens* (Novyi) antitoxin.

Pentavalent Gas Gangrene Antitoxin (U. S. P. 1947 to date) is a sterile solution of antitoxic substances obtained from the blood of

healthy animals which have been immunized against the toxins of *Clostridium perfringens, Clostridium septicum, Clostridium œdematiens* (Novyi), *Clostridium bifermentans* (Sordelli), and *Clostridium histolyticum.* Each package of pentavalent gas gangrene antitoxin shall contain not less than 10,000 units each of *Clostridium perfringens* and *Clostridium septicum* antitoxins, 3,000 units of *Clostridium histolyticum* antitoxin, and 1,500 units each of *Clostridium œdematiens* (Novyi) and *Clostridium bifermentans* (Sordelli) antitoxins.

The several admixtures of gas gangrene antitoxins are designed for use in varying degrees of gas gangrene infection. The average dose, parenteral, therapeutic, or prophylactic, of any of these mixtures is the contents of one or more packages as the initial dose.

Antivenins have been prepared for use in many parts of the world. **North American Anti-Snake-Bite Serum** is a purified and concentrated serum globulin obtained from the blood of horses which have been immunized with snake venoms of North American snakes. This preparation will act as an antidote for the poisons of the copperhead, cotton mouth moccasin and the rattlesnakes.

Tropical American Anti-Snake-Bite Serum (Bothrops antivenin) is prepared from and effective against venoms of the principal poisonous snakes of the genus *Bothrops*, especially *B. atrox* (the Fer-de-lance).

Antivenin Cascabel or **Tropical Rattler Anti-Snake-Bite Serum** is prepared from and effective against the venom of the tropical rattler.

ANTIBACTERIAL SERUMS

Antibacterial serums correspond to antitoxins and antivenins, except that their production in animals is stimulated by endotoxins rather than exotoxins. Therefore injections of the bacterial cells, as found in vaccines or bacterial vaccines, are required. The destruction of the injected cells by the phagocytes tends to liberate in the blood stream several antigens which stimulate the production of several corresponding antibodies. The antibody complex in antibacterial serums is not very well known.

The prophylactic and curative effects of antibacterial serums are not as pronounced and definite as in the case of antitoxins and antivenins.

Some of the better known commercial antibacterial serums are the following Anti-anthrax, Antidysenteric, Antimeningococcic, Antipneumococcic, Antistreptococcic, Antiplague (Yersin's Serum) and many polyvalent serums.

Antimeningococcic Serum, Meningitis Serum (U. S. P. 1936 to 1947; N. F. 1947 to date) is obtained from the blood of an animal immunized with cultures of the several types of meningococci (*Neisseria intracellularis*) which prevail in the United States. Average therapeutic dose by parenteral injection, 20 cc.

Antipneumococcic Serum, Pneumonia Serum—Type Specific (U. S. P. 1936 to 1947; N. F. 1947 to date) is obtained from the blood of an animal which has been immunized with cultures of a pneumococcus (*Diplococcus pneumoniæ*) of one of the types for which a serum has been prepared. Average therapeutic dose by parenteral injection, 20,000 to 100,000 units.

HUMAN SERUMS AND GLOBULINS

Human Serums and **Globulins** containing antibodies are useful in treating certain diseases for which they are recommended.

Human Immune Globulin, Measles Prophylactic or Placental Extract (U. S. P. 1942 to date) is a sterile solution of antibodies obtained from the placental blood and the placentæ expelled by healthy women.

This serum is efficacious in preventing or modifying the attack of measles in exposed, susceptible subjects. The preventive dose ranges from 2 cc. to 4 cc. The dose for modifying the disease after its development is from 3 cc. to 10 cc. depending on the stage of the attack at the time of administration.

Human Measles Immune Serum, Measles Convalescent Serum (U. S. P. 1942 to 1947; N. F. 1947 to date) is sterile serum obtained from the blood of a healthy human who has survived an attack of measles. This serum is efficacious in preventing or modifying an attack of measles in susceptible persons who have been exposed. The average doses are: therapeutic, 20 cc., prophylactic, 10 cc.

Human Scarlet Fever Immune Serum, Scarlet Fever Convalescent Serum (U. S. P. 1942 to 1947; N. F. 1947 to date) is a sterile serum obtained from the blood of a healthy human who has survived an attack of scarlet fever. The average doses are: therapeutic, 20 cc.; prophylactic, 10 cc.

Lactic Acid Organisms.—Metchnikoff advanced the theory that duration of life might be prolonged if measures were taken to control intestinal putrefaction He found that there was a widespread popular belief in the advantage of a diet consisting largely of sour milk, and that there was a fair parallel between unusual longevity and such a diet. He also observed that the cause of much sickness and debility was due to gastro-intestinal auto-intoxication. Lactic acid, due to the action of *Lactobacillus lactisacidi,* in the beverages known as koumys, kefir, yoghurt, rapi and buttermilk, tends to inhibit intestinal putrefaction. This and other organisms (*Lactobacillus bulgaricus* and *L. acidophilus*), especially active in lactic acid production, are prepared in the form of tablets or in suspension in liquids. When such preparations are taken into the stomach, the organisms are not all killed, but pass into the intestines where the bacterial reproduction and lactic acid formation are very active. When these preparations are added to sterile milk, souring ensues and enormous numbers of the bacilli are produced. "Kefir fungi" is a mixture of bacteria and yeast sold in dry form and capable of producing lactic acid fermentation in milk.

Nitrogen-fixing Bacteria.—Nodules or tubercules on the roots of leguminous plants (clovers, alfalfa, soy bean, etc.) contain bacteria (*Pseudomonas radicicola*) which have the power of converting atmospheric nitrogen into nitrogenous compounds soluble in the sap of the plant, thus providing for a marked increase in growth of the plant. The bacteria live upon the food materials in the sap of the plant and thus a true symbiosis results. Pure cultures of the organism can be success-

fully inoculated into the roots of leguminous plants, and by scattering dried cultures of these nitrogen-fixing bacteria in the soil, infection of the growing plants usually results. The production and use of such inoculants is an important phase of agriculture.

Applied Bacteriology.—In the brief space allotted in a few pages, it is impossible to cover adequately even the more important phases of applied bacteriology. Mention cannot be made of many products which are based upon the presence of bacteria or which are due to bacterial action, neither can a detailed discussion be given relative to many industrial operations which depend upon bacterial activity, such as the curing of vanilla, the fermentation of tobacco, the manufacture of vinegar, the tanning of hides, the ripening of cheese and the retting of flax.

Bacteriology as an applied science consists of several special branches, the most important of which are Pathological Bacteriology, Public Health Bacteriology, Dairy Bacteriology, Soil Bacteriology, and Household Bacteriology.

ANTIBIOTIC AGENTS

Antibiotics, from antibiosis meaning "antagonistic association between organisms to the detriment of one of them," have become very important therapeutic agents within recent years.

Penicillin

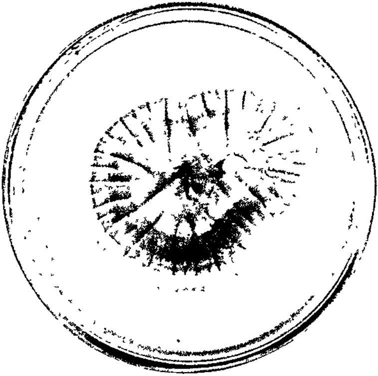
Penicillin was first found by Fleming in 1929. Later, in 1940, a group of Oxford chemists demonstrated its possibilities in medicine.

Preparation.—Penicillin is found in cultures of *Penicillium notatum* and of P. chrysogenum. Definite strains of the mold are used and may be grown using either the surface or submerged culture method. Commercially it is extracted from these cultures by means of organic solvents such as ether, amyl acetate, chloroform and others.

Uses and Dose.—Penicillin is most active on Gram-positive bacteria but the Gram-negative *Neisseria* species are notable exceptions. Largely due to the experience with the wounded and sick in the armed forces (1942 to 1946), it has been established that penicillin may be used successfully in the treatment of a wide variety of diseases, such as those caused by streptococci, staphylococci, gonococci, the bacilli of gas gangrene, and of anthrax, and actinomyces. Encouraging results are being obtained in the treatment of syphilis and also Weil's disease.

Clinically there have been no serious toxic effects and inasmuch as penicillin contains variable amounts of impurities it is altogether possible those effects that are observed may be due to this fact. Chills, fever and urticarial conditions are the most common untoward effects.

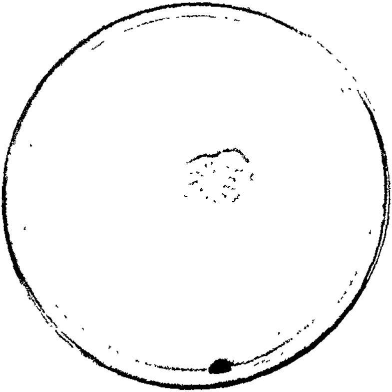
Penicillin is usually combined with calcium or sodium for therapeutic use. These preparations are more stable and somewhat more slowly absorbed and therefore exert their effects over a longer period of time. Penicillin may be administered intramuscularly, intravenously, intrathecally, topically and orally. Penicillin in oil suspension may be



Penicillium notatum N.R.R.L. 1249 B21, descendant of Fleming's strain, used in nearly all surface culture production of penicillin. (Courtesy of Eli Lilly and Company.)

Penicillium notatum showing the penicillus, or spore-bearing head, which identifies a *Penicillium*. (900X.) (Courtesy of Eli Lilly and Company.)

PLATE III



Streptomyces griseus which forms streptomycin when grown by surface culture technique or in submerged culture in fermentation tanks (Courtesy of Eli Lilly and Company)

Actinomyces griseus producer of streptomycin. (1130X.) (Courtesy of Eli Lilly and Company)

injected in very large doses: 300,000 units, intramuscularly, and the effect will extend over two or three days.

Commercial penicillin is not a pure substance but a mixture of several fractions. At the present time, four of these are known and are designated in the United States as G, X, F and K. The relative amounts of these four fractions may vary in commercial penicillins. These fractions differ in their *in vitro* and *in vivo* activity against a variety of bacteria. This condition leads to variable results in therapy. Manufacturers cooperating with the National Institute of Health are trying to improve the preparation of penicillin and produce a more uniform product.

Standards.—Penicillin is standardized in terms of its antibacterial activity and for this purpose a unit of value originally used by the Oxford workers is now known as the Oxford or Florey unit. A unit is equivalent to the smallest amount, which when dissolved in 50 cc. of meat extract broth, completely inhibits the growth of the test strain of *Staphylococcus aureus*.

Pure crystalline sodium penicillin G having 1666 units per mg. has been designated as the international standard. The new international unit has been defined as "the specific penicillin activity contained in 0.6 microgram of the international standard."

The following penicillin items are recognized in the U. S. P.

[illegible]
[illegible] date).
Penicillin Injection in Oil and Wax (U. S. P. 1947 to date).
Penicillin Ointment (U. S. P. 1947 to date).
Penicillin Tablets (U. S. P. 1947 to date).
Penicillin Troches (U. S. P. 1947 to date).

Streptomycin

More recently Waksman, Bugie and Schatz (1944) isolated an antibiotic agent from *Streptomyces griseus* (*Actinomyces griseus*) and named it "Streptomycin." The organism is grown in a suitable medium using the submerged culture type of fermentation. When maximum growth is reached, the broth is separated from the organism and the active agent extracted from it by absorption on carbon, subsequent elution and precipitation.

This agent shows remarkable activity against Gram-negative bacteria including the rod forms but also affects Gram-positive organisms. *In vitro* studies indicate a strong bacteriostatic action against *Mycobacterium tuberculosis*. Its chief value, to date, is that it is active against pathogens not affected by penicillin.

Its use as a therapeutic agent is still in the experimental stage and the results are far from decisive. It has shown remarkable efficiency in treating those ill of tularemia cases clearing up in a few days. It is also of value in treating urinary infections caused by Gram-negative

organisms. Its effect in treating cases of pulmonary tuberculosis, typhoid and brucellosis shows some promise.

It has a low toxicity and may be administered in large doses, but undesirable reactions such as chills, fever, pains in the joints and a histamine-like lowering of the blood pressure have been observed. However, streptomycin appears to be a promising antiobic substance which will rank with penicillin as a valuable therapeutic agent.

Tyrothricin

Another well known antibiotic is Tyrothricin, which is a mixture of gramicidin and tyrocidine produced by *Bacillus brevis,* and was discovered by Dubos in 1939. Its toxicity and lack of solubility limits its use to local therapy against certain of the Gram-positive pathogenic microorganisms. It has proved to be a successful therapeutic agent in treating infected wounds, sinusitis, etc.

ALGÆ

BACILLARIACEÆ, OR DIATOMS.

PURIFIED SILICEOUS EARTH

Siliceous Earth consists of the frustules, whole or broken, of diatoms, and occurs in natural deposits. The material is mined, usually calcined to destroy the organic matter, then washed and dried.

Purified Siliceous Earth, Purified Kieselguhr or Purified Infusorial Earth (U. S. P. 1916 to date) is a form of silica consisting of the frustules and fragments of diatoms, purified by boiling with diluted hydrochloric acid, washing and calcining.

Description.—A very fine but gritty, white, light gray or pale buff, odorless powder, insoluble in water, but readily absorbing about four times its weight of water. For **Tests** c[illegible]

To prepare a moun[illegible] nearly fill it with distilled water, shake vigorously, at once transfer a small quantity of the mixture to another vial containing water, shake well and transfer 10 minims to a clean slide; view in the water or allow the water to evaporate, pass the slide through a flame and mount in Canada balsam.

In the identification of the various genera and species, it is necessary to bear in mind that there are two and sometimes three views presented in the mount of the same species of diatom. Some of the common forms of diatoms occurring in commercial siliceous earth are shown in Figure 13.

PHÆOPHYCEÆ, OR BROWN ALGÆ

The **Algæ** of present economic importance are mostly marine forms, col-[illegible] and [illegible] bund- [illegible] hat of [illegible] weeds

are used to some extent as human and stock food and for manures. They also yield iodine (U. S. P. 1831 to date) in their ash, 0.02 to 0.20 per cent of the dry plant.

Laminaria consists of the cylindrical stipes and basal portions of the midribs of the fronds of *Laminaria digitata* and *L. cloustonii* (Fam. *Laminariaceæ*). The former is a very characteristic kelp which is common north of Cape Cod. The fronds are attached to the rocks and the stout and solid stipe is from 3 to 15 dm. in length, more or less cylindrical below, compressed above and free from distinct mucilaginous cavities (muciparous glands).

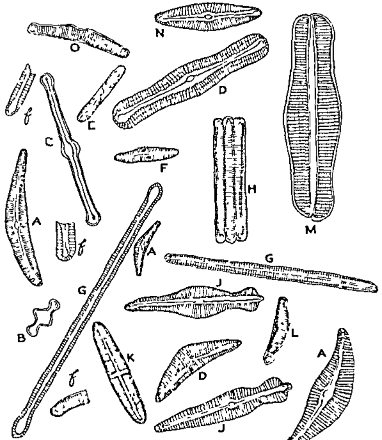


FIG. 25.—Some common forms of diatoms found in Diatomaceous earth. *A*, a species of *Cymbella*; *B*, *Tabellaria floccolsa*, *C*, another species of *Tabellaria*, *D*, two views of *Navicula viridis*, *E*, *Navicula phoenecenteron*, *F*, *Navicula lacustris*, *G*, *Synedra ulna*; *H*, several frustules of a *Navicula*, *J*, *Gomphonema geminatum*, *K*, a species of *Stauroneis*; *L*, *Epithemia hyndmannii*; *M*, some frustules of *Epithemia*, *N*, *Pinnularia brebessonii*, *O*, *Eunotia diodon*, *f*, fragments of broken diatoms (Identified by Charles Boyer, drawn by W. F. Haase.)

L. cloustonii is a common European form and resembles *L. digitata*.

The pieces as dried for commerce are tough, horny, and grayish to dark brown in color. The drug contains about 47 per cent of mucilage, and iodine from 0.06 to 0.11 per cent.

The dry material increases six-fold upon the absorption of water, hence it has been used to absorb moisture from the parts to which it is applied and to enlarge openings through the gentle swelling of the mucilage. As it cannot be sterilized without losing these properties, it has been largely replaced by other materials.

Fucus or Bladderwrack (N. F. 1916 to 1926) is the dried thallus of *Fucus vesiculosus, Fucus serratus, Fucus nodosus* or *Fucus siliquosus* (Fam. *Fucaceæ*).

The plants are common seaweeds growing on rocks near the coast of the northern countries bordering the Atlantic Ocean. The fruiting plants are most active medicinally and are collected in autumn, although fructification continues during the winter, or may be seen to some extent at any time during the year. A number of other species of *Fucus*, as well as other *Algæ*, are gathered under the name of **kelp** off the coast of Cherbourg, France, and Glasgow, Scotland, and are used as a source of iodine and bromine.

The drug is blackish brown, cartilaginous, with a seaweed-like odor and a mucilaginous, somewhat saline and nauseous taste.

Fucus contains from 22 to 62 per cent of carbohydrate substances, consisting mostly of mucilage (algin) and a peculiar cellulose; and from 3 to 24 per cent of tot ... er cent of iodine and some bromine.

... than 3 per cent of foreign organic matter an ... of acid-insoluble ash.

Fucus has been used as an alterative and in the treatment of obesity. Average dose, 0 6 gm.

Sodium Alginate or Algin (N. F. 1947 to date) is the purified carbohydrate product extracted from giant brown seaweeds by the use of dilute alkali. It consists chiefly of the sodium salt of alginic acid, a polyuronic acid composed of beta-mannuronic acid residues, linked so that the carboxyl group of each unit is free while the aldehyde group is shielded by a glycosidic linkage.

Sodium Alginate occurs as a nearly odorless and tasteless, coarse or fine powder, yellowish-white in color. It is readily soluble in water, forming a viscous, colloidal solution. It is insoluble in alcohol, ether, chloroform and in strong acid.

For tests of identity and purity see the National Formulary.

... ater ices, chocolate ... age for *suspending* ... or other industrial purposes.

Aluminum Alginate, formed from algin and aluminum metal, is used for stomach ulcers, and to carry penicillin through the stomach to the intestines where it is absorbable.

RHODOPHYCEÆ, OR RED ALGÆ

Agar

Agar, Chinese, Japanese or Californian Agar (U. S. P. 1916 to date) is the dried, mucilaginous substance extracted from *Gelidium cartilagineum* (Linné) Gaillon (Fam. *Gelidiaceæ*) and from related red *Algæ*.

These algæ grow along the eastern coast of Asia and the western coast of North America.

Agar is prepared in California as follows: The fresh seaweed is washed for twenty-four hours in fresh running water; extracted in steam-heated digesters with dilute agar solution and then with water for a total period of about thirty hours. The hot aqueous extract is cooled and then congealed in ice machines. The water from the agar almost completely separates as ice. The 300-pound agar ice block (containing about 5 pounds of dry agar) is crushed, melted and filtered through a rotary vaccum filter. The moist agar flakes are then dried by currents

of dry air in tall cylinders. The fully dried product can be reduced to a fine powder.

Description and Histology.—See U [illegible]

[illegible] cent of cellulose

Standards.—Agar contains not more than 1 per cent of foreign organic matter, yields not more than 1 per cent of acid-insoluble ash and not more than 20 per cent of moisture.

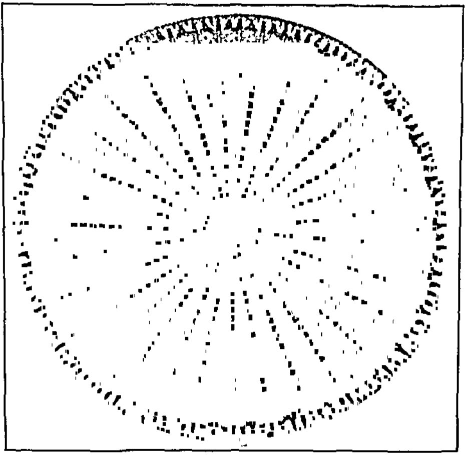


Fig. 28.—*Arachnoidiscus ehrenbergii*, a characteristic Diatom found in agar. (From a photomicrographic negative by J. J. Woodward, Surgeon, U. S. A.)

Agar is insoluble in cold water, but if 1 part of agar be boiled for about ten minutes with 100 parts of water, it yield [illegible] solution of agar, 1 in 100, cooled to 50° C [illegible] when mixed with an equal volume of [illegible] gives more than a slightly reddish or reddish violet color upon the addition of iodine T.S.

Uses and Dose.—Agar is used in medicine as an emollient laxative. Average dose, 10 gm. Agar is extensively used as a gel in bacteriological culture media and in industry for making emulsions, for thickening milk, cream and ice cream; in adhesives; and for sizing textiles, especially silks.

Fucus or Bladderwrack (N. F. 1916 to 1926) is the dried thallus of *Fucus vesiculosus*, *Fucus serratus*, *Fucus nodosus* or *Fucus siliquosus* (Fam. *Fucaceæ*).

The plants are common seaweeds growing on rocks near the coast of the northern countries bordering the Atlantic Ocean. The fruiting plants are most active medicinally and are collected in autumn, although fructification continues during the winter, or may be seen [illegible] year A number of other species of *Fucu*[illegible] under the nam[illegible] land, and are [illegible] bromine.

The drug is [illegible] with a seaweed-like odor and a mucilaginous, [illegible] taste.

Fucus contains from 22 to 62 per cent of carbohydrate substances, consisting mostly of mucilage (algin) and a peculiar cellulose; and from 3 to 24 per cent of total ash, containing from 0.7 to 1 per cent of iodine and some bromine.

The drug should contain not more than 3 per cent of foreign organic matter and yield not more than 4 per cent of acid-insoluble ash.

Fucus has been used as an alterative and in the treatment of obesity. Average dose, 0 6 gm.

Sodium Alginate or Algin (N. F. 1947 to date) is the purified carbohydrate product extracted from giant brown seaweeds by the use of dilute alkali. It consists chiefly of the sodium salt of alginic acid, a polyuronic acid composed of beta-mannuronic acid residues, linked so that the carboxyl group of each unit is free while the aldehyde group is shielded by a glycosidic linkage.

Sodium Alginate occurs as a nearly odorless and tasteless, coarse or fine powder, yellowish-[illegible] colloidal solution.

For tests of iden[illegible]

Sodium Alginate is used in the food industry (ice cream, water ices, chocolate milk, salad dressings, icings, confectionery), and as a mucilage for suspending pharmaceutical and cosmetic mixtures; also as a sizing and for other industrial purposes

Aluminum Alginate, formed from algin and aluminum metal, is used for stomach ulcers, and to carry penicillin through the stomach to the intestines where it is absorbable

RHODOPHYCEÆ, OR RED ALGÆ

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DESCRIPTION AND HISTOLOGY —See U

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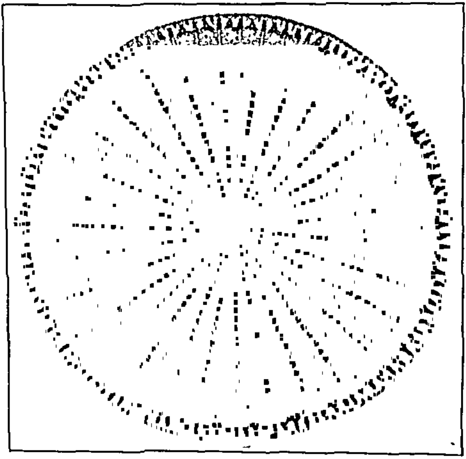

FIG. 26.—*Arachnodiscus ehrenbergii*, a characteristic Diatom found in agar. (From a photomicrographic negative by J. J. Woodward, Surgeon, U. S. A.)

Agar is insoluble in cold water, but if 1 part of agar be boiled for about ten minutes
solutio
when 1
gives ... violet color upon the addition of iodine T.S.

USES AND DOSE.—Agar is used in med

CHONDRUS

Chondrus, Irish Moss or Carrageen (U. S. P. 1842 to 1926; N. F. 1926 to date) is the dried bleached plant of *Chondrus crispus* (Linné) Stackhouse or of *Gigartina mamillosa* (Goodenough et Woodward) J. Agardh (Fam. *Gigartinaceæ*).

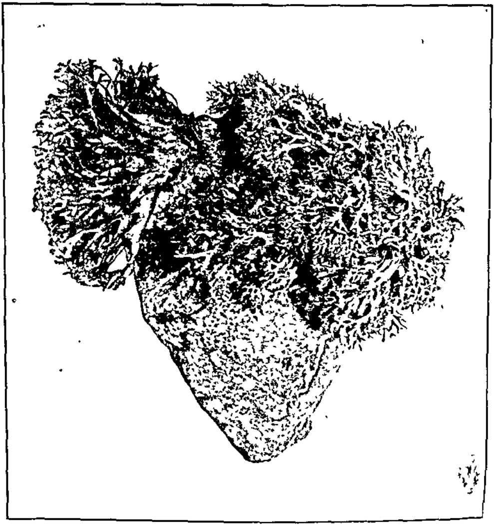

Fig. 27.—Specimen of *Chondrus crispus* attached to the rock where it was found growing along the Massachusetts coast.

These plants are common red algæ found along the northwestern coast of Ireland and the coast of Massachusetts. The plants are collected chiefly during June and July, spread out on the beach and bleached by the action of the sun and dew, then treated with salt water, finally dried and stored. The chief points of collection in this country are 15 to 25 miles south of Boston where *Chondrus crispus* is gathered. *Gigartina mamillosa* is most abundant north of the region where *Chondrus crispus* is collected and thus rarely occurs in the drug collected in the United States, though it is not unusual in the imported Chondrus

Chondrus is an allusion to the cartilage-like character of the dry

thallus; *Gigartina*, to the fruit bodies which appear as elevated tubercles on the thallus. The specific name *crispus* pertains to the curled fronds; *mamillosa* to the small breast-like, stalked fruit bodies or cystocarps.

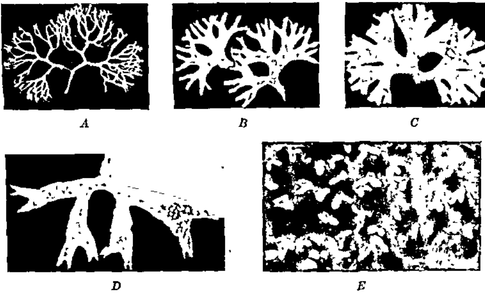

Fig 28.—*Chondrus crispus.* A, Thallus with narrow segments, *B*, with broader segments; and *C*, with very broad segments. *Gigartina mamillosa*, *D*, natural size, showing many of the sporangia-bearing stalks, and *E*, somewhat magnified to show these branched, tubercle-like stalks projecting from the surface of the thallus Photographs made from plants selected from commercial drug, moistened and spread out on glass. (Photo by Paul D. Carpenter)

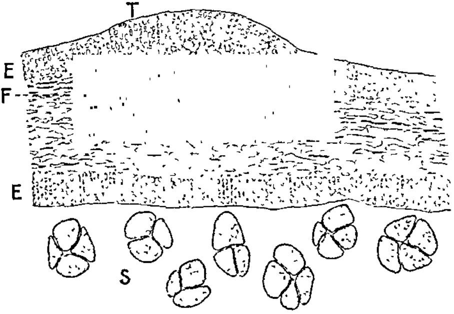

Fig 29 *Chondrus crispus* Transverse section of thallus showing epidermis (*E*), sporangium with spores (*F*), *S*, spores separated in glycerin preparation of thallus by pressure on the cover-glass. The spores occur in groups of four (tetraspores) and the tetrad group is about 30 microns in diameter.

DESCRIPTION, HISTOLOGY AND TESTS OF IDENTIFICATION AND PURITY.—See Figures 27, 28 and 29 and the National Formulary.

CONSTITUENTS.—From 55 to 80 per cent of carrageenin, a mucilaginous principle which is but slightly adhesive; about 10 per cent of proteins, and 10 to 20 per cent of total ash; the inorganic matter consists of calcium carbonate and compounds of sodium, potassium, magnesium and calcium with chlorine, iodine, bromine and sulfur.

USES AND DOSE.—Chondrus is used as a demulcent, a nutrient and a dietetic Its value as a nutrient has been questioned. Average dose, 10 gm. It is used also as an emulsifier and for thickening jellies. Both cold and hot water extracts of chondrus are used as a suspension agent in chocolate milk.

An artificial gum is prepared by adding starch to the mucilage of chondrus, and is said to be a good substitute for acacia, and may be employed as a base for fixing colors in fabrics.

EUMYCETES, OR TRUE FUNGI

The **True Fungi** comprise a multitude of lower plants of quite diverse structure. They are distinguished by the fact that they do not produce chloroplastids and hence are either parasitic or saprophytic. It has been estimated that the several groups comprise about 65,000 species. The economic relations of the fungi to life in general are of great importance, as they are largely responsible for the reduction of the complex compounds of dead organisms into the more simple compounds, such as carbon dioxide, water, nitrates and ammonium salts, which are utilized by photosynthetic plants to build again the foods necessary to maintain life. A few parasitic fungi may cause disease in plant and animal life.

A few fungi are edible and are even cultivated for this purpose. Others are exceedingly toxic and, unfortunately, may be gathered with some of the edible forms found growing naturally. Relatively few are used in medicine, but of these ergot is official in nearly all pharmacopœias.

Certain fungi, especially molds, produce during their growth on certain media powerful substances that destroy certain bacteria; penicillin and streptomycin are examples of these antibiotic substances. The antibiotics appear to be among the most valuable medicinal products and are being used as curative agents in many infectious diseases. (See page 78.)

SACCHAROMYCETACEÆ, OR YEAST FAMILY

Yeasts are unicellular organisms and are usually regarded as being greatly reduced sac-fungi. They feed upon sugars, splitting the latter to form alcohols and carbon dioxide; hence yeasts are of great importance in the alcohol industry and also in the making of bread, where the liberated carbon dioxide tends to swell the dough, making it porous and "light." Yeast is also used medicinally.

YEAST

The following titles of Yeast have been official: **Cerevisiæ Fermentum, Brewer's Yeast** (U. S. P. 1820 to 1831), **Fermentum, Brewer's Yeast**

(U. S. P. 1863 to 1882), **Cerevisiæ, Fermentum Compressum, Compressed Yeast** (N. F. 1916 to 1936; as a fermentative reagent, U. S. P. 1916 to 1936; N. F. 1916 to date), **Saccharomyces Siccum, Dried Yeast** (U. S. P. 1944 to date).

Brewer's Yeast is a viscid, semi-fluid, frothy mass containing the living cells of *Saccharomyces cerevisiæ*, or of other species of *Saccharomyces*, associated with bacteria and molds. Pure strains of yeast may be grown in suitable culture media containing sucrose and certain salts or proteins.

When yeast is grown at a temperature of 15° to 20° C. the cells are larger, tend to "bud" and form chains of cells and rise to the top of the fermenting mas [illegible] e be kept near or below 10° [illegible] reproduce from spores, and [illegible] e fermenting mass and constitute "bottom" yeast.

Compressed Yeast is brewer's yeast or purer strains of yeast, partially dried by expression of water and admixed with a starchy or absorbent base. These yeast "cakes" wrapped in air-proof foil maintain the life of the yeast cells for a relatively long period of time.

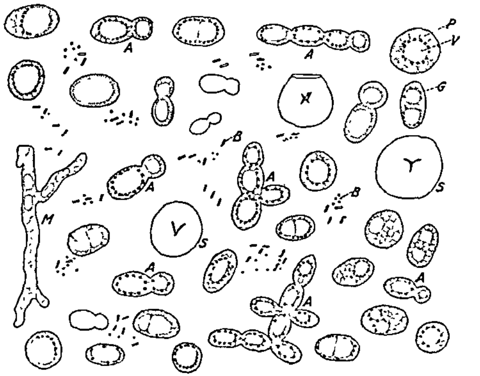

FIG. 30 — Yeast cells in compressed yeast and brewer's yeast. *A*, budding cells, *P*, protoplasm, *V*, vacuole, *G*, granules showing molecular motion, *M*, foreign mold, *B*, bacteria, *S*, cassava starch grains in yeast cake. (Drawing by Hogstad.)

Dried Yeast or Dry Yeast (U. S. P. 1944 to date) consists of the dried cells of any suitable strain of *Saccharomyces cerevisiæ* Meyen. Dry Yeast may be obtained as a by-product from the brewing of beer which has been made from cereal grains and hops. The yeast cells are washed free

of beer, and may or may not be debittered. Dry Yeast also may be obtained by growing suitable strains of yeast, using media other than those required for the production of beer, and under appropriate environmental conditions. Yeast should be labeled to show its source as "Brewer's Dried Yeast," "Debittered Brewer's Dried Yeast" or "Primary Dried Yeast."

DESCRIPTION AND HISTOLOGY.—Dried Yeast occurs as yellowish white to weak yellowish orange flakes, granules or powder with an odor and taste characteristic of the type. As the yeast cells are dead, it is inactive in fermenting power. For a description of

CONSTITUENTS.—Yeast

diastase and invertase; nu

antineuritic vitamin B.

STANDARDS.—Dried Yeast contains not less than 40 per cent of protein and in each gram, the equivalent of not less than 0.12 mg. of thiamin hydrochloride, 0.04 mg. of riboflavin and 0.25 mg. of nicotinic acid. The live bacteria count shall not exceed 7500 pe

USES AND DOSE.—I

contents. It has some

value. Average dose. 1 to 20 gm. daily according to the needs of the patient.

Concentrated or Dried Aqueous Yeast Extracts, prepared from specially cultured or brewer's dried yeast, are presented in liquid, powdered or tablet form.

HYPOCREACEÆ, OR FLESH-CONSUMING FAMILY

ERGOT

Ergot, Rye Ergot or Secale Cornutum (U. S. P. 1820 to 1947; N. F. 1947 to date) is the dried sclerotium of *Claviceps purpurea* (Fries) Tulasne, developed on rye plants.

Prepared Ergot or Powdered Defatted Ergot (N. F. 1947 to date) is ergot which has been powdered, immediately deprived of most of its fat, and dried.

The fungus has two distinct periods in its life history, an active and a resting stage. During the latter it forms a compact mycelium, or sclerotium, which replaces the flowers and grains of rye. The generic name *Claviceps* alludes to the club-like character of the sclerotium, *purpurea* to its purple color.

Ergot is picked by hand from the ears of rye, or it is separated after the threshing of the rye; it is carefully dried and preserved in rather tight containers against the attacks of insects by the use of small quantities of carbon tetrachloride or chloroform.

Ergot deteriorates when moist, even becoming moldy and rotten; it should be thoroughly dried, then kept dry in storage or transportation. The use of a cartridge of a non-liquifying, inert, dehydrating substance to maintain low humidity of the ergot, is desirable. Ergot deteriorates with aging, even though kept dry, yet well-preserved Prepared Ergot is known to have retained its therapeutic values for at least six years.

DESCRIPTION AND HISTOLOGY.—See Figures 31 and 32 and the National Formulary.

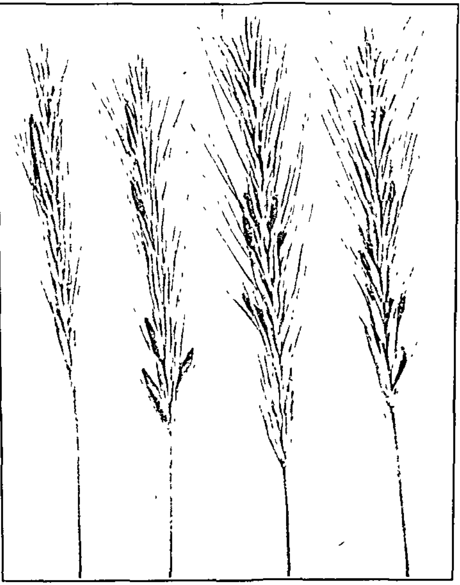

FIG 31 —Ergot sclerotia developed in heads of the rye plant. (Photo by C. J. Zufall)

CONSTITUENTS.—Ergot contains several active alkaloids (see below) and amines, as well as amino-acids, coloring matter, sterols, glycosides, sugars, 30 to 35 per cent of fixed oil, etc

STANDARDS —Ergot contains not more than 8 per cent of moisture, and Prepared Ergot not more than 6 per cent of moisture. For Tests of Identity and Purity see the National Formulary.

USES AND DOSE.—Ergot is a vaso-constrictor and antihemorrhagic, and stimulant of uterine contractions in parturition Average dose 2 gm.; of Prepared Ergot, 0 3 gm

Ergot Alkaloids:

Potent	*Relatively inactive*	*Formula*	*Discoverer*
Ergotoxine	Ergotinine	$C_{35}H_{39}O_5N_5$	Barger and Carr (1906)
Ergotamine	Ergotaminine	$C_{33}H_{35}O_5N_5$	Spira and Stoll (1920)
Ergosine	Ergosinine	$C_{30}H_{37}O_5N_5$	Smith and Timmis
Ergocristine	Ergocristinine	$C_{35}H_{39}O_5N_5$	Stoll and Burckhardt
Ergonovine	Ergometrinine	$C_{19}H_{23}O_2N_3$	Thompson, Kharasch, Dudley and Moir (1935)

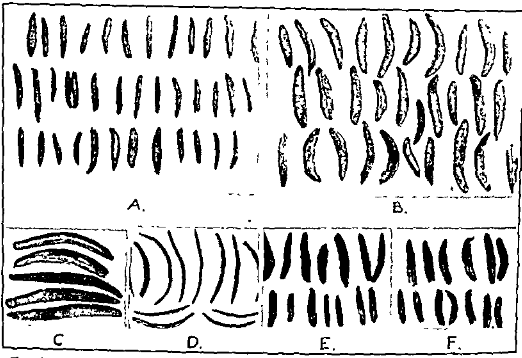

FIG 32 —Ergota *A*, Russian ergot; *B*, Spanish ergot; *C*, extra large Spanish ergot, *D*, Dyss ergot from Algeria, *E*, ergot of rye from Wisconsin, *F*, ergot of wheat (About ½ natural size) (Photos by Paul D Carpenter.)

These alkaloids, in isomeric pairs, yield a common product, lysergic acid, and the isomerism is believed to occur in this part of the molecule. Other products of hydrolysis may differ for each pair of the alkaloids.

Ergotoxine Ethane Sulfonate (as reference standard: U. S. P. and N. F. 1936 to date) is used as a reference standard in the assay of ergot. It is official in the British
is a white cryst
or in a mixture

a s in colorless crystals or
of . or in alcohol. For Tests

Ergotamine closely resembles ergotoxine in its oxytocic activity but is about one-half as toxic as the latter, as shown in the convulsive and lethal dosage for rabbits. The salt is remarkably effective for the symptomatic relief of migraine, usually within one hour. Average dose. intramuscular 0.5 mg, oral 1 mg.

Ergonovine Maleate (U. S P. 1936 to date) occurs as a white or faintly yellow, odorless microcrystalline powder, affected by light, readily soluble in water, less soluble in alcohol. The alkaloid was discovered by three groups
ause
the
beu-

taneously is sometimes noted within five minutes after giving the dose, and its effect is more marked than that of either ergotoxine or ergotamine. However, the vasoconstrictor effect is much less marked. Average dose: intravenous or intramuscular 0.2 mg , oral, 0.5 mg.

Ergot Amines:

Ergot contains at least two potent amines; namely, Histamine and Tyramine.

Histamine Phosphate or Histamine Acid Phosphate (U. S. P 1936 to date) is a phosphate of *b*-iminazolylethylamine. It is found in ergot, apparently as a decomposition product of histidine, though it is usually obtained from certain putrid meat products and may be classed as a ptomaine. The salt occurs as colorless, odorless, long prismatic crystals, soluble in about four parts of water. For Tests of Identity and Purity see the U. S. Pharmacopœia.

Histamine Phosphate reduces blood pressure and is a powerful stimulant of the excised uterus. Average dose. 0 3 mg.

Histidine Monohydrochloride (N. F 1947 to date) occurs as small, glistening, colorless crystals, nearly odorless and with a salty taste. It is readily soluble in water and in alcohol. For Tests of Identity and Purity see the National Formulary.

Histidine is an indispensable amino acid and may be broken down to yield histamine The known pharmacologic effects of histidine are relatively slight, it is reputed to have a marked effect on the relief of gastric ulcers. Average dose. 0.2 gm.

Tyramine is closely related to epinephrine in chemical structure and in pharmacologic action, though it is much less powerful than epinephrine, and more closely resembles the action of ephedrine. It is mainly responsible for the pressor effect of ergot

Ergosterol, found in ergot oil and in certain other oils, is the only known substance to give rise to vitamin D upon irradiation with ultra-violet light (see page 667).

Ustilago or Corn Smut (U S. P 1882 to 1894) is the fungus, *Ustilago zeæ* (Fam *Ustilaginaceæ*) developed upon the stems and flowers of the Indian corn (
from
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non-reducing sugar, and yields about 4.5 per cent of ash.

Corn smut has been used medicinally somewhat like ergot but is weaker and of lower toxicity.

Agaric, White Agaric or Larch Agaric (N. F. 1916 to 1930) is the dried fruiting body of the fungus *Polyporus officinalis* (Fam *Polyporaceæ*), deprived of its outer rind

The commercial supplies are obtained from the mountainous regions of Southern Europe and Siberia, the product being collected from larch trees.

Agaric occurs in light, spongy, irregular pieces, mostly 8 to 14 cm in diameter, externally yellowish white to yellowish brown and showing at places the characteristic porous surface so common in the genus; easily cut, having a corky texture; internally whitish or light brown with yellowish striations and sometimes a smooth shiny surface, and occasionally with pieces of larch wood embedded, odor aromatic; taste slightly aromatic, acrid and intensely bitter

The drug contains about 50 per cent or more of resin consisting of four resinous substances. α-resin, reddish, bitter and pungent; β-resin or agaricinic acid, the most important principle, forming yellowish crystals which are slightly

soluble in water and ether and very soluble in boiling water or hot alcohol; γ-resin, 3 to 4 per cent, amorphous; δ-resin, soft and in small quantities. It also contains a fatty substar ... nnic acid, phosphoric acid, malic acid, ...) to 30 per cent, and ash from 1 to 2 p ... osphorus.

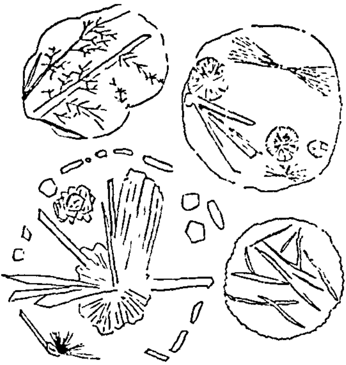


Fig. 33.—Sublimate crystals obtained by heating small quantities of powdered *Polyporus officinalis*. The crystals resemble those of agaricinic acid. The sublimate consists first of slightly colored globules, in which on drying there separates needles or needle aggregates and in some cases large plates, which are strongly polarizing and show extinction parallel with the long axis. (After Tunmann.)

Agaric yields not less than 50 per cent of non-volatile extractive, when treated with boiling alcohol

Agaric and agaricinic acid p ... to atropine in the effect of su ...

Surgeon's Agaric, or Boletu ... grows on beech and oak trees ... broad and 10 cm. thick at the tree The fungus is deprived of its hard rind, cut into thin slices, boiled in weak lye, washed, and beaten with mallets until soft. It is then of a cinnamon-brown color, glossy, soft and velvety. It was used by surgeons for absorbing body fluids, blood, etc., which could then be washed out and the agaric dried for further use. When antisepsis became known, the use of agaric for this purpose ceased.

Poisonous Fungi.—On account of the high protein content in some of the edible fungi, varying from 20 to 60 per cent in the dried material of *Agaricus* ... in foreign countries, ... Persons who make ... what to gather, for numerous serious cases from the eating of poisonous fungi are reported every year. The pharmacist may be called upon to identify the species which has been the cause of poisoning. A very excellent Bulletin has been prepared by Flora W. Patterson and Vera K. Charles of the Bureau of Plant Industry, U. S. Department of Agriculture, entitled, "Mushrooms and Other Common Fungi."

LICHENES, OR LICHENS

Lichens are a peculiar group of plants, composed of certain of the higher fungi parasitic upon one of the green or blue algæ. They are of rather common occurrence upon the barks of trees and rocks, and some grow upon soil. They consist of a thallus in which the algal cells have a more or less definite position. (See Fig. 34.)

FIG 34.—Iceland moss (*Cetraria islandica*) *A—F*, Various forms of thalli showing apothecia (*a*), *I*, cross-section of an apothecium showing the hymenium (*h*), the hypothecium (*p*), the algal layer (*c*), the medullary layer (*m*), and lower or ventral surface (*l*), *K*, an ascus with eight ascospores and two paraphyses from the hymenium (*h*)

Many lichens contain lichenin, a carbohydrate resembling starch, hence they have a certain food value and a few have been used as food. While some are of medicinal interest their chief interest is in the coloring principles which they contain and which have been the subject of painstaking investigations by O. Hesse during many years.

Cetraria or Iceland Moss (U S. P. 1820 to 1905) is the entire dried plant of *Cetraria islandica* (Fam. *Parmeliaceæ*), which is widely distributed over the northern part of both hemispheres The chief commercial supplies are obtained from Scandinavia, Germany, Switzerland and parts of Austria

Cetraria consists of a number of somewhat dichotomously branching, more

or less curled, papery, fringed segments, 5 to 10 cm. long and about 5 mm. wide. The upper surface is greenish brown, with occasional dark reddish brown cupular apothecia, and the under surface grayish, with numerous small, whitish, depre t brittle when dry. It has a slight odor

Co (about 70 per cent); the former is lik solution gels upon cooling but is not colored blue with iodine; the latter is like soluble starch, the cold aqueous solution giving a blue reaction with iodine; cetrarin, a bitter crystallizing principle, yielding on hydrolysis cetraric acid, which is also intensely bitter; lichenostearic acid; several organic acids including fumaric or lichenic acid; cellulose; sugar; gum; thallochlor, resembling chlorophyll; and yields less than 2 per cent of ash

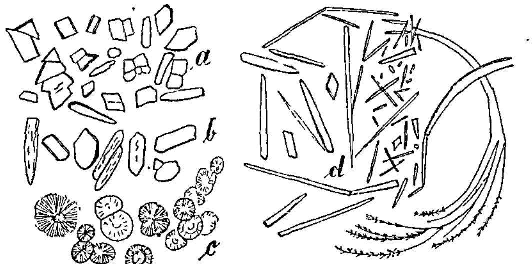


FIG 35 —Crystals of lichenostearic acid obtained by microsublimation of pieces of the thallus of Cetraria, not larger than 0 5 cm. square. *a*, Crystals obtained by sublimation; *b*, a granular sublimate which was recrystallized from alcoholic solution, *c*, sublimate treated with sodium carbonate and showing crystal aggregates of the sodium salt of lichenostearic acid, *d*, sublimate treated with ammonia giving crystals of the ammonium salt of lichenostearic acid. (After Tunmann.)

The bitter principle in cetraria may be removed by treating the drug with a 1 per cent solution of potassium carbonate at about 60° C. for several hours

Iceland moss jelly is prepared by making a decoction of 3 parts of washed cetraria and 100 parts of water, adding 3 parts of sugar and evaporating the whole to 10 parts **Dried saccharated Iceland moss** is prepared somewhat similarly to the Iceland moss jelly, but the product is evaporated to dryness and then powdered.

Cetraria is a demulcent and nutrient. Average dose, 10 gm. in the form of a decoction.

Allied Plants.—Lichens of allied families also yield sugars· *Usnea barbata* and *Cornicularia aculeata* contain a principle resembling lichenin, which on hydrolysis yields glucose *Evernia* everninn, which resembles lichenin but is de contains 30 per cent of mannose; *Stereocaul* yield on hydrolysis dextromannose and dextrogalactose.

ORCHIL, LITMUS AND CUDBEAR

Orchil or Archil is a coloring substance obtained by the fermentation of *Roccella tinctoria*, *R. fuciformis* and other lichens (Fam. *Roccellaceæ*). *R. tinc-*

toria is abundant in the Levant, the Canary Islands and the Cape Verde Islands, while *R. fuciformis* is quite common on the islands of the Indian Ocean adjoining the African coast. The lichens grow on the rocks near the sea and after being cleansed they are ground into a pulp with water. They are then treated with some ammoniacal liquid, such as dilute solution of ammonia and allowed to ferment for nearly a week.

Orcinol (as reagent; U. S P. 1916 to 1926; N. F 1942 to date) is obtained from certain lichens by fermentation of orchil, or is prepared synthetically.

Orcinol occurs as colorless, monoclinic crystals, soluble in water, alcohol and ether. Orcinol is converted by alkaline fermentation to orcein which produces scarlet solutions with either water or alcohol. Orcein is readily soluble in alcohol, somewhat soluble in water, and insoluble in ether. It forms beautiful lavender-colored solutions with the alkalis.

Litmus (as reagent: U. S. P. 1926 to 1936, 1942 to date, N F. 1942 to date).

Litmus Test Solution (U. S. P. 1882 to 1926, 1942 to date, N. F. 1936 to date).

Red and Blue Litmus Paper (U S P. 1882 to date; N. F. 1936 to date).

Azolitmin (U. S. P. 1916 to 1926, 1942 to date; N. F. 1936 to date).

Litmus, Lacmus, Turnsole or Lacqueblue is a blue pigment prepared from various species of *Roccella, Lecanora* or other lichens (Fam *Parmeliaceæ*).

The process of fermentation is similar to that in the preparation of orchil and cudbear, but potassium carbonate is added and the time of fermentation is longer. When the color of the solution is of the desired tint it is mixed with cal dried. Most of

r granules of an indigo blue or deep violet color It has a somewhat fragrant odor and a pungent, saline taste tinging the saliva a deep blue. The indicator substances contained in litmus are soluble in water and less soluble or insoluble in alcohol. For Tests and Standards see the National Formulary

Azolitmin is a water-soluble coloring matter obtained from litmus; it occurs in dark violet scales, easily soluble in hot water and in dilute alkalis, forming a deep blue solution.

Cudbear (N. F. 1916 to date) is a powder prepared from species of *Roccella* DeCandolle, *Lecanora* Acharius, or other lichens (Fam. *Parmeliaceæ*).

Cudbear is prepared in much the same manner as orchil. The coloring principle is apparently orcein Cudbear is used as a coloring agent for pharmaceutical preparations as well as in dyeing

Description —Cudbear occurs as a very dusky red or red-purple powder, showing under the microscope fragments of hyphæ and pseudo-parenchyma from the lichen, but very little woody or leafy tissue

Standards.—Cudbear, extracted with water or with alcohol, forms a deep red solution which is rendered lighter in tint by the addition of acids, and is changed to purplish-red on the addition of alkalis. For further standards see the National Formulary.

BRYOPHYTA OR BRYOPHYTES

The **Bryophytes** (from two Greek terms meaning "moss plants") include the liver-worts and the true mosses. They show a true alternation of generations; *i. e.*, the sporophyte, or asexual form and the gametophyte or sexual form. The sporophyte tends to show a differentiation into stems, leaves and root hairs, which absorb soil solutes and serve as holdfasts. The plants are chlorophyll-bearing, hence are neither saprophytic nor parasitic. There are about 3000 species of mosses, widely scattered in all climates and under many soil conditions, though they generally require an abundance of moisture.

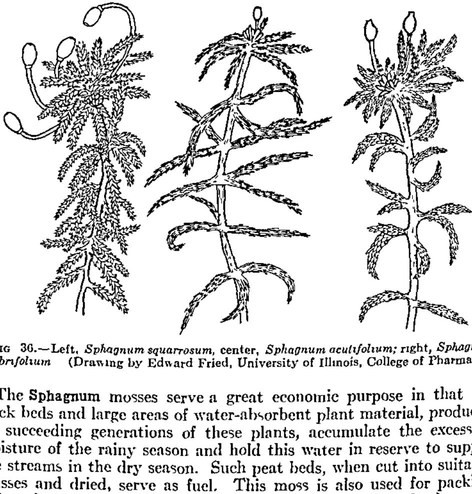


FIG 36.—Left, *Sphagnum squarrosum*, center, *Sphagnum acutifolium*; right, *Sphagnum cymbrifolium* (Drawing by Edward Fried, University of Illinois, College of Pharmacy.)

The **Sphagnum** mosses serve a great economic purpose in that the thick beds and large areas of water-absorbent plant material, produced by succeeding generations of these plants, accumulate the excessive moisture of the rainy season and hold this water in reserve to supply the streams in the dry season. Such peat beds, when cut into suitable masses and dried, serve as fuel. This moss is also used for packing living plants for shipment. The shredded, cleaned and dried sphagnum moss is utilized for absorptive purposes. It is more absorptive than prepared cotton and, in the form of pads, serves many useful purposes.

PTERIDOPHYTA OR PTERIDOPHYTES

The **Pteridophytes** include the ferns (*Filicales*), the horsetails or scouring-rushes (*Equisetales*), and the club mosses or lycopodiums (*Lycopodiales*).

The *Pteridophyta* constitute a very old group of plants, being first found in the Devonian and attaining their maximum development in the Carboniferous age, during which time they formed the bulk of the vegetation comprised in the coal measures. The existent forms are still numerous, exceeding 5000 species. Their chief economic value lies in their use as ornamental plants.

EQUISETALES

The *Equisetaceæ* or Horsetail Family is the only family of this order. It furnishes but little of medicinal value.

Equisetum is the herb [illegible] *nale*, Scouring-rush, these ha[illegible] The former plant contains eq[illegible]

Other species of *Equisetum* contain the alkaloid equisetine, which is destructive to cattle Certain other species have been used as intestinal and urethral astringents.

FILICALES

The *Filicales* or true ferns are widely scattered, and comprise more than 4000 living and 900 known fossil species, the living species being classified into 9 families. Practically all of our common ferns belong to the families *Polypodiaceæ* and *Osmundaceæ*.

The *Filicales* possess a stem, usually an underground creeping stem or rhizome, which bears roots below and fronds above. The fronds consist of a petiole or stipe and an expanded lamina, often lobed or divided into pinnæ The sporangia often develop on the under surface of the lamina, but sometimes the whole lamina becomes a spore-bearing organ. The sporangia frequently are clustered in a sorus, a small, circular, brownish swelling which eventually breaks open and scatters the spores. The spore falling into a moist and shady spot will develop into the gametophyte, a flat, green prothallus, which bears the sexual spores on the underside adjacent to the earth. Cross fertilization occurs by means of the water currents and a chemotactic influence. After fertilization, a new plant develops and this sporophyte becomes the typical fern plant.

POLYPODIACEÆ, OR POLYPODIUM FAMILY

ASPIDIUM

Aspidium (U. S. P. 1831 to date) consists of the rhizome and stipes of *Dryopteris Filix-mas* (Linné) Schott (U. S. P. 1831 to date), known

in commerce as European Aspidium or Male Fern, or of *Dryopteris marginalis* (Linné) Asa Gray (U. S. P. 1882 to 1916, 1942 to date), known in commerce as American Aspidium or Marginal Fern.

Dryopteris Filix-mas is a perennial wood fern, widely distributed, being indigenous to Europe, Asia, North America west of the Rocky Mountains, and the Andes of South America. *Dryopteris marginalis* is found in the Eastern and Central United States and north to Prince Edwards Island. The drugs are collected in early autumn and trimmed to leave the lower portions of the stipes attached to the rhizome; or the stipes are separated from the rhizome and the dark brown periderm removed. The drug should be carefully dried and preserved.

The generic name *Dryopteris* is from the Greek meaning a fern growing on oaks; the specific name *filix-mas* means "male fern" in reference to its asexual fructification; the specific name *marginalis* pertains to the marginal position of the sori in this species.

DESCRIPTION AND STRUCTURE.—See Figure 37 and the U. S. Pharmacopœia

CONSTITUENTS.—Ether extracts 6 5 to 15 per cent of oleoresin from the drug, which contains the active principle, namely amorphous filmaron, a complex dibasic acid, and amorphous filicic acid Filicin or crystalline filicic acid may be an anhydride of amorphous filicic acid. Only the amorphous acidic compounds are considered to be anthelmintic The drug also contains fixed oil, tannic acid, several resins, sugar, and about 2.7 per cent of total ash.

STANDARDS —Aspidium contains not less than 1 5 per cent of crude filicin. The acid-insoluble ash is not more than 3 per cent.

USES AND DOSE.—Aspidium is an anthelmintic used in the treatment of tape- [illegible] e oleoresin. It sh[illegible] being preferre[illegible] filicic acid, which is dangerous when absorbed in large amounts. In case the treatment fails, ten days or more should elapse before a second administration.

ADULTERANTS.—The rhizomes of other ferns are sometimes substituted for those of the true drug, such as that of *Osmunda claytoniana* and related species. These occur in large pieces with coarse, wiry roots, and flattened stipes and free from chaffy scales

The rhizome of *Dryopteris spinulosa* (Shield Fern) appears to possess properties similar to the official drug; it somewhat resembles that of *D. filix-mas*, but the chaffy scales possess marginal glandular hairs and the number of fibrovascular bundles in the rhizome is usually but 6 or 7. The rhizome of the **Lady Fern**, *Athyrium filix-fœmina* has also been found as an adulterant.

The rhizome of *Pteridium aquilinum* contains a cyanogenetic amygdalin-like glucoside.

[illegible] *pedatum* or *A capillus-veneris*. These [illegible] in Eastern and Central United States an[illegible] as demulcents, [illegible] en to question. [illegible] d delicate of the North American fer[illegible] and with blackish roots. [illegible]

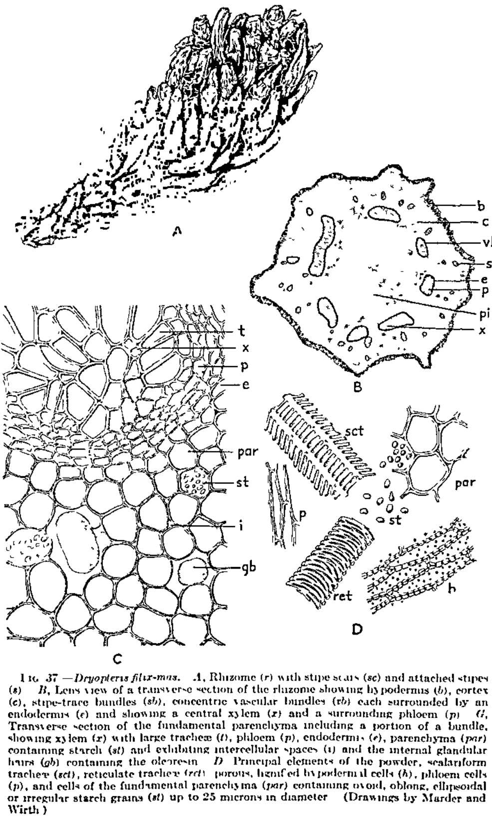


FIG. 37.—*Dryopteris filix-mas.* A, Rhizome (*r*) with stipe scars (*sc*) and attached stipes (*s*). B, Lens view of a transverse section of the rhizome showing hypodermis (*b*), cortex (*c*), stipe-trace bundles (*sb*), concentric vascular bundles (*vb*) each surrounded by an endodermis (*e*) and showing a central xylem (*x*) and a surrounding phloem (*p*). C, Transverse section of the fundamental parenchyma including a portion of a bundle, showing xylem (*x*) with large tracheæ (*t*), phloem (*p*), endodermis (*e*), parenchyma (*par*) containing starch (*st*) and exhibiting intercellular spaces (*i*) and the internal glandular hairs (*gb*) containing the oleoresin. D, Principal elements of the powder, scalariform tracheæ (*sct*), reticulate tracheæ (*ret*), porous, lignified hypodermal cells (*h*), phloem cells (*p*), and cells of the fundamental parenchyma (*par*) containing ovoid, oblong, ellipsoidal or irregular starch grains (*st*) up to 25 microns in diameter. (Drawings by Marder and Wirth.)

the surface is glaucous and very smooth. The odor is slight, the taste being slightly bitter and somewhat astringent. For the structure consult Holm, Merck's Report, 1909, page 62.

LYCOPODIALES

The clubmosses differ widely from the ferns and horsetails in both sporophytic and gametophytic characteristics. Many fossil forms, larger and more complicated in structure than any living forms, are known. The living clubmosses are mostly tropical, but some are widely distributed in the temperate regions. Two families are included: *Lycopodiaceæ* and *Selaginellaceæ*.

LYCOPODIACEÆ, OR CLUBMOSS FAMILY

But two genera, *Lycopodium* and *Phyloglossum* are included in this family.

The *Lycopodiums* (about 100 species) are perennial herbs found over most of the globe. They possess a herbaceous, creeping or pendant, somewhat branching stem. The leaves are small, lanceolate, sessile, evergreen, and arranged spirally around the stem, or in four ranks with the opposite leaves on the flattened sides of the stem somewhat larger, and those on the edges, smaller The fruiting bodies are strobiles with green leaf-like scales (*L. selago*), or smaller yellow scales on a thin upright branch (*L. clavatum*).

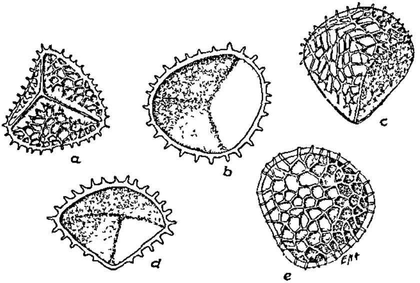


Fig. 38 —Spores of *Lycopodium clavatum*, showing markings in the form of protuberances on the cell wall *a*, *c*, and *e*, the whole spores, *b* and *d* sectioned spores showing the interior but without cell contents. (Drawings by Gathercoal)

LYCOPODIUM

Lycopodium (U. S. P. 1863 to 1947; N. F. 1947 to date) consists of the spores of *Lycopodium clavatum* Linné. The spores are obtained from the ripened cones by shaking the fruiting tops on cloths, and the

extraneous matter is removed by sifting. The principal sources of supply are Esthonia, Latvia, Western Russia and Switzerland.

The generic name *Lycopodium* is derived from the Greek and has reference to the fancied resemblance of the shoots of the plant to the foot of a wolf; the specific name *clavatum* refers to the club-like character of the strobile.

DESCRIPTION.—A light-yellow, very mobile powder, nearly inodorous and [illegible] wetted by it, but sinking on being boiled [illegible] own into a flame The spores are some- [illegible] convex base, from 25 to 40 microns in [illegible] the reticulations being polygonal and formed by straight-sided delicate ridges which form a delicate fringe at the edges of the spore, when viewed with the rounded surface of the spore on the under side, a distinct triangular marking is seen, formed by the edges of the flat surfaces of the spore.

CONSTITUENTS.—About 50 per cent of a deep green odorless, non-drying oil with an acid reaction, which consists chiefly of oleic acid. The spores yield about 1 per cent of ash On heating with a solution of potassium hydrate, monomethylamine is liberated, and on macerating the spores in alcohol, a part of the alcohol is converted into an aldehyde.

USES —Lycopodium is used as a dusting powder to protect tender surfaces and as an absorbent. In pharmacy it is used to prevent the adhering of pills and suppositories.

ADULTERANTS —Lycopodium is sometimes admixed with pine pollen, starchy materials, and various inorganic substances, as sulfur, talc and gypsum. A recent adulterant of lycopodium has been found to consist of corn starch which had been treat [illegible] artificial lycop[illegible] resin) at near [illegible] then dried an[illegible] are detected by means of the microscope.

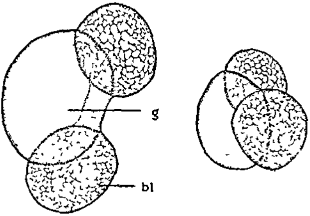


FIG. 39 —Pine pollen *g*, pollen grain; *bl*, bladder or "air-sac." (Drawing by Adamson)

[illegible]

Brazil. *L. polytrichoides*, of the Haw[illegible] *um*, of Venezuela; *L. cernum*, of the Tropics, and *L* [illegible] loyed in medicine.

SPERMATOPHYTA OR SPERMATOPHYTES

The Spermatophytes (seed-bearing plants) represent the most complex types of the plant kingdom. They are mostly chlorophyll-bearing, with but very few parasitic or saprophytic forms; they usually produce well differentiated roots, stems, leaves, and flowers, and, by sexual fertilization, seed. The seed may be produced on exposed bracts (the Gymnosperms) or in closed carpels (the Angiosperms). The number of species, approximately 133,000, probably is greater than is found in all other groups of plants. Most of our vegetable drugs come from the Spermatophytes.

GYMNOSPERMÆ OR GYMNOSPERMS

This is an ancient order of plants which arose in the Devonian and reached its zenith in the Carboniferous Period. It was especially predominant during the Triassic Age. The surviving forms are represented by about 650 species, divided into the *Cycadales, Ginkgoales, Coniferales* and *Gnetales.*

CYCADALES OR CYCADS

Only a single family, the Cycadaceæ, including 9 *genera and* about 100 species, constitutes this order. It yields no medicinal products of importance, but several economic products of value. These plants possess a thick, unbranched, cylindrical stem, sometimes very short, but again reaching a height of 60 feet. The leaves, usually pinnately compound, are borne spirally around the stem, leaving, as they decay, the bases of the petioles covering the stem; in older plants, the leaves form a crown at the top of the stem.

The sago palms, species of *Cycas,* furnish an important economic product, namely, the starch found in the stem, which constitutes **Sago.** (See pages 120 and 148.)

GINKGOALES

Only a single species, *Ginkgo biloba,* widely cultivated as an ornamental tree, but native to China, is found in this order. The leaves are not "evergreen" or needle-shaped, but drop at the end of the growing season and are broadly fan-shaped. In structure, the stem resembles the Conifers *and in fruit-bearing, the Cycads.*

CONIFERALES OR CONIFERS

The Conifers (cone-bearing) include several families, 46 genera and about 500 species. The plants are mostly resinous trees or shrubs, with stems which possess *a pith, a circle of open* collateral bundles, and a true bark. The leaves are evergreen, usually sessile and either narrow, linear or needle-shaped, or flat and scale-like. The fruits are cones usually with woody bracts but sometimes fleshy.

The Conifers are of great economic importance for their timber and for ornamental purposes, as well as for many valuable resinous or oleo-resinous products, which include the natural oleoresins, obtained as natural exudations or by incising the trunks, the volatile oils and resins, obtained by distillation of the oleoresins; the "tars" and "pitches," obtained by destructive distillation of the wood or the resin; and the volatile oil (especially from the leaves) obtained by steam distillation. These plants also yield valuable tanning barks, medicinal barks, medicinal fruits and, in some instances, seeds used for human food.

Plant Products from the Coniferales

Because this group of plants is noted for its resinous products, a general discussion of these products will be presented at this point.

Resins probably never occur free in plants but are associated with other plant products, such as volatile oils, gums, benzoic acid, cinnamic acid, or small amounts of other substances.

Resinous plant products are produced normally during growth or are secreted as a result of injury to the plant. They usually occur in cells, sacs or canals especially formed by the plant for the purpose of holding them. Resins occur in 33 families of the Spermatophytes.

RESINS

When resins are separated and purified they are usually brittle, amorphous solids which fuse readily upon heating, after passing through a preliminary stage of softening. They are insoluble in water, but dissolve in alcohol or other organic solvents, forming solutions which, on evaporation, deposit the resin as a varnish-like film. Resins burn with a characteristic, smoky flame.

Resins may be considered as final products in destructive metabolism. Many are believed to be oxidation products of the terpenes. They are usually more or less complex mixtures and their principal constituents may be classified as follows:

Resin Acids.—These contain a large proportion of oxy-acids, usually combining the properties of carboxylic acids and phenols They occur both in the free state and as esters They are soluble in aqueous solutions of the alkalies, usually forming soap-like solutions or colloidal suspensions Their metallic salts are known as resinates, and some of these are used extensively in the manufacture of cheap soaps and varnishes. Examples of these are abietic acid in rosin or colophony, copaivic and oxy-copaivic acid in copaiba, guaiaconic acid in guaiac, pimaric (pimarinic) acid in Burgundy pitch and frankincense, sandaracolic (sandaracinolic) acid in sandarac, aleuritic acid in shellac, and commiphoric acid in myrrh

Resin Alcohols.—Complex alcohols of high molecular weight, known as **resinotannols**, are those which give a tannin reaction with iron salts; and [illegible]

isolated aloeresinotannol from aloes, ammoresinotannol and galbaresinotannol from ammoniac, peruresinotannol from balsam of Peru, siaresinotannol and

sinnaresinotannol from benzoin, and toluresinotannol from balsam of tolu. The following are examples of resinol resins: benzoresinol from benzoin, storesinol from styrax, gurjuresinol from gurjun balsam, and guaiacresinol from guaiac resin.

Resenes.—Complex neutral substances devoid of characteristic chemical properties. They do not form salts or esters, and are insoluble in and resist hydrolysis by alkalies. They include alban and fluavil from gutta percha, copalresene from copal, dammaresene from dammar, dracoresene from dragon's blood, olibanoresene from olibanum.

Gluco-resins.—These are complex mixtures yielding sugars and complex resin acids on hydrolysis, as the resins of jalap and scammony.

Pharmaceutical Resins are obtained (1) by extracting the drug with alcohol and precipitating the resin in water, as with resins of jalap, scammony, ipomea and podophyllum; (2) by separating the oil from oleoresin by distillation, as rosin from turpentine and copaivic resin from copaiba; (3) by heating the plant part, as guaiac resin from guaiac wood; (4) by collecting the natural product that has exuded as oleoresin from the plant through natural or artificial punctures and from which the natural oil has partially evaporated into the atmosphere, as Burgundy pitch, mastic, sandarac, dragon's blood, etc.; (5) by collecting fossil resins, such as copal, kauri, dammar, etc.

OLEORESINS

Oleoresins are more or less homogeneous mixtures of resins and volatile oils.

There is no sharp line of demarcation between these various types of resinous substances, and classification is sometimes difficult; thus guaiac resin, which is not usually regarded as a gum-resin, may contain as much as 10 per cent of gum; small proportions of volatile oils are present in many resins, such as mastic and sandarac.

The **natural oleoresins** from the *Coniferales* include the turpentines (American, Bordeaux, Austrian, French, Venice, Strasburg), Oregon balsam, Canada balsam, Burgundy pitch, Canada pitch, spruce gum and sandarac. Those named first are liquid oleoresins, the latter ones semi-solids or solids. Usually, there is a *small amount of "natural" exudation from the trees due to insect stings*, broken branches, etc., but the commercial supplies are generally obtained by artificial incision through the bark and even into the wood.

GUM-RESINS

Gum-resins are mixtures consisting chiefly of resin and gum. The gum is usually a glycosidal substance similar in composition to gum acacia. Probably the only true medicinal gum-resin is gamboge, which contains no volatile oil.

Oleo-gum-resins are mixtures of resin, gum, and volatile oil and frequently small quantities of other substances. The principal medicinal oleo-gum-resins are myrrh, asafetida, galbanum, ammoniac and olibanum (frankincense).

BALSAMS

Balsams are resinous mixtures which contain large proportions of benzoic and cinnamic acids. Benzoin is sometimes referred to as a bal-

samic resin. The medicinal balsams include balsam of tolu, balsam of Peru, styrax (Levant and American), and benzoin (Sumatra, Siam, etc.).

VOLATILE OILS

These products are discussed very extensively in another location (see page 523), but are mentioned here especially because natural oleoresins are occasionally distilled and the volatile oil portion is separated as a valuable medicinal product. *This is especially true of oil of turpentine.* In other cases the coniferous leaves or twigs or fruits are steam-distilled to yield the volatile oil that is used in medicine, such as pine-needle oil, oil of juniper, oil of savin, etc.

PRODUCTS OF DESTRUCTIVE DISTILLATION

When the wood or resin of the pines is heated without access of air, a decomposition takes place and a number of volatile compounds are driven off, and charcoal remains. The condensed volatile matter usually separates into two layers: an aqueous layer containing wood naphtha (methyl alcohol) and pyroligneous (crude acetic) acid, and a tarry liquid constituting pine tar This dry distillation is usually conducted in retorts, and if the wood be chipped or coarsely ground and the heat be applied rapidly, the yield of tar is about 10 per cent of the wood taken. The chief medicinal products are pine tar and juniper tar.

TURPENTINE

Turpentine, Gum Turpentine or Gum Thus (U. S. P. 1820 to 1916; N. F. 1916 to date) is the concrete oleoresin obtained from *Pinus palustris* Miller and from other species of *Pinus*.

"Gum" turpentine or "Gum" is a common name among the collectors and dealers, but it is a misnomer from the scientific standpoint.

Turpentine is collected in North and South Carolina, Georgia and Northern Florida. (See Fig. 40.) The trees form vast forests, and turpentine "camps," including a "still," are set up in the particular block of trees to be "worked" for the season. The larger trees are 18 to 20 inches in diameter, though trees as small as 4 or 6 inches in diameter may be "boxed." If skillfully "worked" they will yield turpentine for fifteen to twenty years Spraying the freshly chipped faces with 40–60 per cent sulfuric acid, increases and prolongs the flow.

Description —Turpentine occurs in yellowish, opaque masses, lighter internally, more or less glossy, sticky when warm, brittle in the cold. Odor and taste characteristic

It i [illegible]

The [illegible] than 2 per [illegible] as a counter-irritant

Allied Products —*Pinus tæda*, a tall tree growing in the regions where *Pinus palustris* is found, yields an oleoresin like turpentine, though in lesser amount. *Pinus sylvestris*, or Scotch pine, which is indigenous to the mountains

of Europe and Asia and extensively cultivated in this country, is the source
much of the turpentine used in Europe.

Bordeaux Turpentine is a product resembling American turpentine, and
obtained from *Pinus pinaster* and other species of *Pinus* growing in Southe
France, the resin consisting chiefly, however, of the anhydride of pimaric ac

FIG. 40 Collection of turpentine The oleoresin is secreted in the sap wood an
obtained by making triangular incisions into the bark and wood in the spring of the y
it flows into cavities ("boxes") cut lower down in the trunk, or into containers attac
to the tree The thick liquid which collects in the boxes or containers is removed
barrels and taken to the stills The product of the first year's cutting is of supe

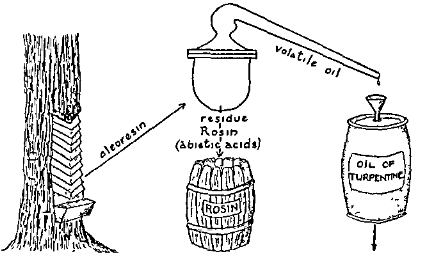
tainers and is largely resin. (Photo by B V Christensen, Gainesville, Fla.)

Venice Turpentine, or Larch Turpentine (N. F. 1916 to 1926) is an oleore
obtained from *Larix europæa* This larch is indigenous to the mountains
Central Europe and is extensively cultivated. Incisions are made into
heartwood in the spring and then plugged until the fall, when the viscid liq
is collected by means of a spoon. From each incision about 250 cc. is obtai

annually. The oleoresin is secreted by the tree for only a few years. Commercial supplies come mostly from the Southern Tyrol.

The oleoresin is a thick, nearly clear and transparent liquid of a yellowish,

cent. Venice Turpentine may be adulterated with rosin or American turpentine



1. Turpentine	2 Resin	3 Turpentine oil
Distilled over NaOH	+ H_2SO_4	+ HNO_3 + C_2H_5OH
4. Rectified turpentine oil	5 Terebene	6 Terpin hydrate

FIG. 41.—Diagrammatic scheme illustrating the relation between the official products obtained from *Pinus palustris* (Drawing by E H. Wirth)

Strasburg Turpentine is the product of the European silver fir (*Abies pectinata*). It closely resembles the Canada turpentine, but has a lemon-like odor. It contains 24 to 30 per cent of a greenish, fluorescent volatile oil, consisting chiefly of *l*-pinene.

Oregon Balsam.—This is obtained from the Douglas fir (*Pseudotsuga doug-* ...ates and British Columbia. The ... draining by means of a spout, ... to those of Canada turpentine For microscopic technique it is not to be recommended, as it gradually becomes granular and opaque.

Spurious mixtures have been sold under the name of "oregon balsam," and for th

Car ... is a li ... nous ... vesicles or blisters on the surface, from ... with the spout of the can used by the ... in Quebec.

... yellow, occasionally with a greenish fluorescence, transparent, with an agreeable, terebinthinate odor, and a bitter, slightly acrid taste

Canada balsam contains 16 to 25 per cent of volatile oil, consisting chiefly of *l*-pinene, and 70 per cent or more of resinous substances.

Canada Balsam, as a mounting medium (U. S. P. 1916 to date; N. F. 1926 to date) consists of the resin, freed from volatile oil, and dissolved in xylol to form a solution of suitable density. It is used mainly for mounting microscopic specimens and as a cement for lenses.

Burgundy Pitch (U. S. P. 1820 to 1905) is the resinous exudation of the stems of the Norway spruce fir (*Picea excelsa*), an evergreen tree indigenous to Europe and Northern Asia. The resin is obtained by making incisions through the bark into the wood, the resin exuding and solidifying; it is then collected and purified by melting it in hot water and straining the mixture.

Burgundy ... more or less plastic ... times brittle, ... taste aromatic and sweetish.

It consists chiefly of two crystallizable resins, about 5 per cent of a volatile oil (isomeric with oil of turpentine), to which its peculiar fragrance is due; and about 10 per cent or less of water, which is included during the preparation.

Burgundy Pitch is a stimulant and counter-irritant. Formerly it was much employed in medicinal plasters.

Canada (or Hemlock) Pitch (U. S. P. 1831 to 1894) is the oleoresin of the common hemlock (*Tsuga canadensis*) and is obtained by making incisions in ... of the wood and bark ... , reddish brown, opaque ... robably contains similar constituents.

... large shrub of ... to facilitate th... ered with a wh... transparent; od... uished from mastic in that it is not plastic when chewed.

... mainly in varnishes.

... alis, ... ving

Spruce Gum is a natural exudation on the branches of the black or bog spruce ... spruce (*P. canadensis*). It is ... northern New England and C... trunk, the finest flavor and c...

It consists largely of a gummy substance, a small quantity of volatile oil (apparently a simple terpene), and several resins. It has medicinal properties and uses similar to gum turpentine; though rarely used medicinally, thousands of tons of spruce gum are used annually in chewing gum.

TURPENTINE OIL

Turpentine Oil, or "Spirits" of Turpentine (U. S. P. 1820 to 1947; N. F. 1947 to date) is the volatile oil distilled from the oleoresin obtained from *Pinus palustris* Miller and other species of *Pinus* which yield turpentine oils exclusively.

of
to
at

CONSTITUENTS.—It consists almost entirely of pinene, which in the American oil is mostly dextrorotatory, while in the European oil it is levorotatory.

USES.—It is used externally as a counter-irritant and a mild antiseptic.

Allied Products.—Austrian turpentine oil is derived from *Pinus nigra*, and

hile it resembles

Rectified Turpentine Oil (U. S. P. 1894 to 1947; N. F. 1947 to date) is turpentine oil rectified by distillation from an aqueous solution of sodium hydroxide. It is to be dispensed when turpentine oil is required for internal use. It is used as an expectorant, diuretic, urinary antiseptic and anthelmintic. Average dose, 0.3 cc.

Terebene (U. S. P. 1894 to 1942) is a mixture of terpene hydrocarbons, chiefly dipentene.

Oil of turpentine is repeatedly treated with concentrated sulfuric acid until the residual "oil" is optically inactive.

Terebene is a strong stimulant to the mucous membrane and is used as an expectorant and antiseptic. Average dose: 0.25 cc.

Terpin Hydrate (U. S. P. 1894 to 1947; N. F. 1947 to date) is formed by the action of nitric acid on rectified oil of turpentine in the presence of alcohol. It is the hydrate of the dihydroxy alcohol terpin ($C_{10}H_{18}$-$(OH)_2.H_2O$).

Terpin Hydrate is a stimulant to the mucous membrane, therefore an expectorant, diuretic and diaphoretic. Average dose, 0.25 gm.

Resin, Rosin or Colophony (U. S. P. 1820 to 1947; N. F. 1947 to date) is a solid resin obtained from *Pinus palustris* Miller and other species of *Pinus*.

The commercial grades of rosin vary in color from light amber (the finest or "water-white" grade) to almost black (and very dirty); the latter is used principally for destructive distillation and the production of "rosin oils." Rosin has a great variety of technical uses. Only the light-colored transparent rosins are used medicinally.

DESCRIPTION.—Usually in shiny, sharp, angular fragments; translucent, amber-colored, often covered with a yellowish dust; hard, brittle, easily pulverizable, fracture shallow-conchoidal; odor and taste faintly terebinthinate,

volatile

neutral

ethyl sulfate in a test-tube, the mixture assumes a rose, then violet, and finally a deep violet color

The alcoholic solution of rosin becomes milky-white on addition of water, and on heating fragments of rosin in water they melt, flow together and form a sticky mass.

CONSTITUENTS.—From 80 to 90 per cent of an anhydride of abietic acid, which, on treatment with alcohol, is changed into crystalline abietic acid; sylvic acid, which is probably a decomposition product of abietic acid; ash, not more than 0.1 per cent.

Uses.—Rosin is used in cerates, plasters and ointments. It is slightly antiseptic and stimulant. It is employed in veterinary medicine as a diuretic. Rosin is not infrequently used as an adulterant of other resinous products, as of Burgundy pitch and Venice turpentine. A mixture of rosin and oil of turpentine is sometimes substituted for the latter.

Pine Tar (U. S. P. 1820 to date) is a product obtained by the destructive distillation of the wood of *Pinus palustris* Miller and other species of *Pinus.*

Description.—Semifluid, viscid, blackish brown, non-crystalline, transparent in thin layers, becoming granular or crystalline (due to the separation of pyrocatechin) and opaque with age; odor peculiar, empyreumatic, aromatic; taste pungent. Pine tar is miscible with alcohol, ether, chloroform, fixed or volatile oils, and solutions of potassium or sodium hydrate. It is heavier than water and slightly soluble in it; the solution is of a pale yellowish brown color and has an acid reaction; it yields with a dilute solution of ferric chloride, a reddish color, and with a stronger solution an olive-green color, due to the presence of pyrocatechin (distinguishing it from juniper tar); and is colored brownish red by an equal volume of calcium hydrate test solution. The petroleum ether extract is colored greenish by a 0.1 per cent solution of copper acetate

Constituents.—Pine tar consists of a resinous substance, with which is admixed a small quantity of turpentine, acetic acid, methyl alcohol, and various volatile empyreumatic substances On distillation four distinct classes of products are obtained: (1) An aqueous distillate, from 10 to 20 per cent, consisting chiefly of acetic acid, methyl alcohol and acetone. (2) A light oily distillate, from 10 to 15 per cent, coming over under 150° C., and consisting of mesitylene, toluene, xylene, cumene, methene and eupion, which products are used as solvents for varnishes and similar substances. (3) A heavy oily distillate, about 15 per cent, distilling over between 150° and 250° C., and consisting of the creosote oils, viz.: phenol, cresol, creosote, paraffin, naphthalene, pyrene, chrysene, retene and some other substances (4) A black resinous mass, called **pitch** (50 to 65 per cent) which has the odor of tar and is still official in some pharmacopœias, under the name **Pix Nigra.**

Uses and Dose.—Pine tar is an irritant and parasiticide. It is also an expectorant [illegible]

Oil [illegible] volatile oil distilled from pine tar. Upon s [illegible] color and forms a tarry deposit.

Rectified Tar Oil (U. S. P. 1916 to 1947; N. F. 1947 to date) is the volatile oil from pine tar, rectified by steam distillation.

Description.—It is limpid, at first colorless, but gradually darkening to a reddish brown, and with a strong empyreumatic odor and taste, but does not form a tarry deposit. It is soluble in all proportions in alcohol. It consists largely of hydrocarbons, such as pinene, some phenol compounds, acetic and other acids.

Uses and Dose.—It is used as an expectorant and in ointments or lotions as a parasiticide and an irritant. Average dose: 0.2 cc.

PINE OIL

Pine Oil (N. F. 1947 to date) is a volatile oil composed chiefly of tertiary and secondary terpene alcohols obtained by extraction and fractionation or by steam distillation of the wood of *Pinus palustris* Miller and other species of *Pinus.*

For either the extraction or distillation process, the wood is shredded, then fractionally steam-distilled to yield wood turpentine (coming over first) and pine oil. The dry chips are then extracted with a light petroleum distillate, which extract upon fractional distillation yields the solvent, pine oil and rosin.

DESCRIPTION.—Pine Oil is a colorless to light amber liquid with a characteristic pinaceous odor. It is easily miscible with alcohol. Specific gravity 0.925 to 0.937 at 25° C. For other constants and tests see the National Formulary.

CONSTITUENTS.—Largely a terpineol; also appreciable quantities of terpenes, secondary and tertiary alcohols; and the phenolic ether, methyl chavicol.

USES.—It is valuable in certain disinfectants and insecticides, especially in the veterinary field. It is an excellent carrier of pyrethrins and rotenone. It also has other important industrial uses; in flotation processes; in textile and paint manufacture, as a source of synthetic oils and perfumes.

Pine Oil Emulsion Concentrate (N. F. 1947 to date) is a concentrate prepared from pine oil and water using soap, sulfonated oil or other suitable emulsifying agent. It contains not less than 65 per cent, by volume, of pine oil, and not more than 10 per cent of water. It is completely miscible with 19 parts of water.

A satisfactory concentrate may be made from 74 per cent of pine oil, 8 per cent each of rosin soap and linseed soap, and 10 per cent of water. Other formulas also furnish the official concentrate.

The concentrate is a clear, colorless or pale yellow liquid, which when diluted with water (1 to 20) yields a stable emulsion. This emulsion has a phenol coefficient of 3 to 4. It is very extensively used as a disinfectant in stables, cattle cars and trucks, stock yards, etc., and as an insecticide in cattle sprays.

PINE NEEDLE OIL

Dwarf Pine Needle Oil or Pine Needle Oil (U. S. P. 1916 to 1947; N. F. 1947 to date) is the volatile oil distilled with steam from the fresh leaves of *Pinus mugo* Turra (*Pinus pumilio* Haenke). It contains not less than 3 per cent and not more than 10 per cent of esters calculated as bornyl acetate.

The Swiss mountain pine or dwarf pine is closely related to the cultivated ornamental mugho pine in the United States.

The oil is almost colorless with a pleasant, aromatic odor and a bitter, pungent taste. It is soluble in less than 10 volumes of 90 per cent alcohol, though frequently with turbidity.

The oil contains from 5 to 7 per cent of bornyl acetate, also cadinene, phellandrene, pinene and sylvestrene.

It is used as an inhalant with expectorant, stimulant and mildly antiseptic properties.

Siberian Pine Needle Oil, distilled from the leaves of *Abies siberica*, contains up to 40 per cent of bornyl esters.

Scotch Pine Needle Oil, distilled from the leaves of *Pinus sylvestris*, and German, Swedish and English Pine Needle Oils have been used medicinally.

JUNIPER

Juniper or Juniper Berries (U. S. P. 1820 to 1873, N. F. 1916 to date) is the dried fruit of *Juniperus communis* Linné and its variety *depressa* Pursh.

The generic name *Juniperus* is from the Celtic meaning rough and refers to the foliage; the specific name *communis* is from the Latin meaning, the ordinary kind. The plants are small evergreens with subulate, prickly-pointed, verticellate leaves; the fruit is a galbulus. They are indigenous to North America, Europe and Asia, the fruit being gathered in Italy, Hungary, eastern Germany and Sweden. Most of the commercial product comes from Italy. It is said that fruits from the southern climates contain larger amounts of volatile oil. Besides their pharmaceutical use, Juniper berries are employed in the manufacture of certain varieties of gin.

Description and Structure.—See Figure 42 and the National Formulary.

Powder.—Moderate brown to dark yellowish brown; odor aromatic; taste sweet, mildly terebinthinate, slightly bitter; it shows fragments composed of stone cells, the latt
oxalate from 5 to 3
showing the polygc
and of endosperm tissue.

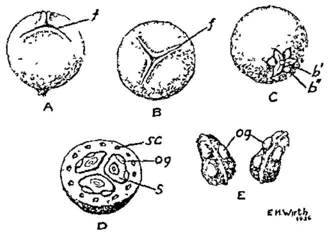


Fig. 42. *Juniperus communis* Fruits nearly globular, about 8 mm. in diameter, externally smooth, shining, dark brown to dark purple with a blue-gray bloom. *A*, *B* and *C*, entire fruits showing the 3-rayed furrow (*f*) at the apex marking the cohesion of the three fleshy bracts and at the base two whorls of yellowish bracts, the outer whorl consisting of three narrow pointed bracts (*b'*) and the inner of three broader pointed bracts (*b"*). *D*, Transversely cut fruit showing numerous large schizogenous cavities (*sc*) in the flesh of the bract and the three triangularly ovate seeds (*s*) with large oil glands (*og*) on the surface. *E*, Seeds showing the large oil glands (*og*) on the surface (Drawing by Wirth)

Constituents.—Juniper contains 0.5 to 1 5 per cent of volatile oil; 10 per cent of resin, 15 to 30 per cent of dextrose; a yellow coloring principle; and yields 2 to 4 per cent of ash.

Standards —Juniper contains not more than 10 per cent of immature or discolored fruit of the plant and not more than 3 per cent of other foreign organic matter, and yields not more than 2 per cent of acid-insoluble ash.

Uses and Dose.—Juniper is a diuretic. Average dose: 4 gm.

Juniper Oil (U. S. P. 1820 to 1947; N. F. 1947 to date) is the volatile oil distilled with steam from the dried ripe fruit of *Juniperus communis* Linné and its variety *depressa* Pursh.

This oil is a nearly colorless, limpid liquid having the characteristic odor and taste of juniper berries. It forms a neutral solution in 4 volumes of alcohol. The oil contains pinene, cadinene and juniper camphor.

USES AND DOSE.—The oil is used as a diuretic, emmenagogue and genito-urinary antiseptic. Average dose: 0.1 cc.

Juniper Tar or Oil of Cade (U. S. P. 1894 to date) is the empyreumatic volatile oil obtained from the woody portions of *Juniperus oxycedrus* Linné.

The heart wood of the shrub which is known as prickly cedar, and is indigenous to southern France and other countries bordering the Mediterranean, is cut into shavings, which are packed into tight retorts or kilns with a drain, and then heated for several hours or days. The distillate separates into an upper oily layer, which constitutes the official product, middle aqueous layer, and a lower layer of pitch.

DESCRIPTION.—A viscid, clear, dark-brown liquid, with a tar-like odor and a pungent, bitter taste. It is partially soluble in alcohol and in petroleum benzin, and completely soluble in amyl alcohol, chloroform, glacial acetic acid and in oil of turpentine. It will almost completely dissolve in 3 volumes of ether. It imparts an odor and taste and an acid reaction to water, and the aqueous solution gives a red coloration with very dilute ferric chloride solution.

CONSTITUENTS.—The sesquiterpene, cadinene, associated with some phenolic

the wood of the root of *Pinus sylvestris*, contains *d*-pinene, *d*-sylvestrene, and, in Swedish oil, dipentene.

Lignum Juniperi, or Juniper
of *Juniperus communis*, is offic
commerce in pieces varying fr
usually adhering. The wood of the root is preferred to that of the stems and branches in that it is more aromatic. It contains a small quantity of volatile oil and resin.

The **Juniper Wood Oil** of commerce consists apparently of oil of turpentine to which some juniper oil has been added, or it is turpentine oil which has been added to juniper wood or branches and redistilled. The oil is used to some extent in veterinary medicine.

CEDAR

Savin, or Sabina (U. S. P. 1820
of *Juniperus sabina* Linné, an ev
regions of southern and central
young twigs are collected in the
volatile oil they are used in the green state.

The branchlets are covered, except near the base, with closely appressed scale-like leaves which are grayish or brownish green, rhomboidal, about 1 mm. long, 4-ranked, closely imbricated, thus completely covering the branchlets, and each leaf shows in cross-section a single large oil gland directly beneath the epider
present.
The starc
dermal fib

are numerous, also fragments of narrow tracheids and of epidermis and hypodermis.

Savin contains from 4 to 6 per cent of a volatile oil, consisting of about 10 per cent of an alcohol, sabinol; 40 to 44 per cent of an ester of sabinol; pinene; cadinene; and a principle with an odor of cuminic aldehyde; also a resin and a small amount of tannin.

The drug is a diuretic. Average dose: 0.6 gm.

Savin Oil (U. S. P. 1840 to 1916) is steam distilled from the young fresh twigs of *Juniperus sabina* Linné and is similar in properties and uses to juniper oil. It has a marked stimulating effect on the uterus, hence is a powerful and dangerous emmenagogue and abortifacient.

Thuja, White Cedar or Arbor Vitæ (U. S. P. 1882 to 1894; N. F. 1916 to 1936) is the young twigs of *Thuja occidentalis* Linné, a conical tree indigenous from Quebec to Virginia, west to Minnesota and Manitoba, and extensively cultivated.

The leaves are 4-ranked and of two kinds; one opposite pair are more or less elongated, clasping, and triangular in section; the other pair is flattened, oppressed and with a prominent oleoresin gland near the middle of the under surface; the arrangement of the leaves is such as to give the branches a flattish appearance. The fruits are small cones with 6 to 10 carpels, each bearing a narrow-winged seed.

Thuja contains 1 per cent of a volatile oil with an odor resembling tansy; it contains *d*-pinene, *l*-fenchone, *d*-thujone, and an inactive oxime; the drug ... ujin which resembles quercitrin; a bitter ... The two latter principles are also found

... n emmenagogue and an irritant. The average dose of the drug is 2 gm.

Cedar Leaf Oil, Oil of Thuja or Oil of Arbor Vitæ (U. S. P. 1942 to date) is the volatile oil distilled with steam from the fresh leaves of *Thuja occidentalis* Linné.

DESCRIPTION.—Cedar l ... istic, pleasantly aromatic ... volumes of 70 per cent alc ... calculated as thujone For other constants and assay process see the U. S. Pharmacopœia

CONSTITUENTS.—Ceda ... pinene the first two giving the

USES AND DOSE.—Th ... dose, abortifacient and convulsan ... and an antiseptic. It entered the ... for lavender oil in soap liniment, Average dose. 200 mg.

Red C ... of *Juniperus virgi* ...

The fruit ... *sabina.* ... as cedarwood oil and occurs to the extent of 2.5 to 4.5 per cent. The oil consists of cedrol, or so-called cedar camphor, and cedrene.

Cedar Oil or Cedarwood Oil (U. S. P. 1916 to date) is a selected commercial oil distilled from the wood of red cedar, *Juniperus virginiana* Linné, with a refractive index of about 1.504 at 20° C., to be used for "clearing" sections of plant or animal tissue for viewing under the microscope.

Immersion Oil is cedar oil especially prepared to have a refractive index of exactly 1.515 at 18° C., for use with homogeneous immersion lenses.

PINACEOUS BARKS

White Pine (N. F. 1916 to date) is the dried inner bark of *Pinus strobus* Linné. The White or Weymouth Pine is the principal timber

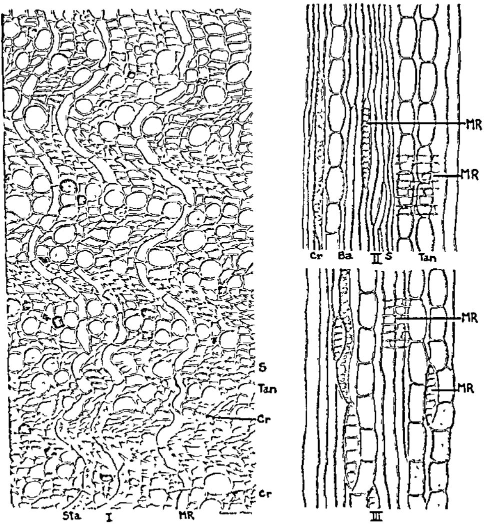


FIG. 43.—White pine bark. *I*, Transverse section; *II*, radial-longitudinal section; [illegible] fiber-like cells with unthickened non-lignified walls; *S*, sieve with more or less collapsed, narrow, elongated cells; *Sta*, starch; *Tan*, large, longitudinally elongated tannin cells. (Drawing by Martz.)

pine of the northern United States and Canada. The outer corky layer of the bark is removed before the inner portion is dried.

Pinus is the ancient Latin name, probably akin to *pinna*, meaning a feather, and has reference to a somewhat feather-like foliage of many of the species. The specific name *strobus* pertains to the cones or strobiles.

Description, Histology and Powder.—See Figure 43 and the National Formulary.

Constituents.—The alcoholic extract forms about 30 per cent of the drug and contains tannic acid and an oleoresin; the bark contains considerable mucilage and a small quantity of coniferin; the latter is usually present in the cambial layer of all of the species of *Pinus* as well as in other genera of the *Pinaceæ*. Total ash is not more than 2 per cent and adhering outer bark not more than 1.5 per cent of the drug.

Larch Bark is the inner bark of the branches and trunk of *Larix decidua*. It occurs in quills and flattened, more or less transversely curved pieces, outer surface light to dark red, inner surf
short-fibrous; odor aromatic; taste
contains scattered groups of stone
varying in shape from branching tc
fibers Larch bark contains 10 to 15 per cent of tannin, a small quantity of volatile oil, resin and larixinic acid. The latter sublimes at 93° C., forming crystals resembling those of benzoic acid. It is allied to pyrogallol and pyrocatechin and occurs mostly in the bark of young trees.

Hemlock Bark from *Tsuga canadensis*, is very extensively used in the United States for tanning. The inner bark is used to some extent in medicine as an astringent. The drug comes in flattened pieces, varying in size; the outer surface is cinnamon-brown or blackish brown and longitudinally wrinkled, or evenly furrowed; inner surface yellowish brown to cinnamon-brown, finely striate and with numerous small crystals; fracture short in the outer portion and strongly fibrous in the inner bark; the odor is faint and the taste strongly astringent. It contains from 10 to 15 per cent of tannin and a small quantity of volatile oil and resin.

GNETALES

This order contains but one family, the *Gnetaceæ*, a small family of three genera and about forty species, of great interest to botanists, since it connects the Gymnosperms with the Angiosperms. Several species of *Gnetum* yield edible fruits and gums. Medicinally the genus *Ephedra* is of the greatest interest. At least three groups of *Ephedra* species have been studied for their active constituents: (*a*) the Asiatic group consisting of *E. sinica*, *E. equisetina* and other species; (*b*) the European group, *E vulgaris* variety *helvetica;* (*c*) the American group, six or more species found in southern California and Mexico. Probably none of our American species contains an alkaloid, but the Chinese plant, *E. sinica*, contains the alkaloid ephedrine.

EPHEDRA

Ephedra or Ma-Huang is the entire plant, or the overground portion of *Ephedra sinica* grown in China. In Chinese characters "Ma" means astringent and "Huang" means yellow, probably referring to the taste and color of the drug. It has been used as a medicine in China for more than five thousand years. Its use in modern medicine began with the recent discovery of the valu-

able properties of ephedrine The plant is found near the sea coast in southern China and the drug is exported from Canton

The plant is a low, diœcious, practically leafless shrub, 60 to 90 cm. high T' ir a blossoms appear in the summer.

For the structure see Figure 44

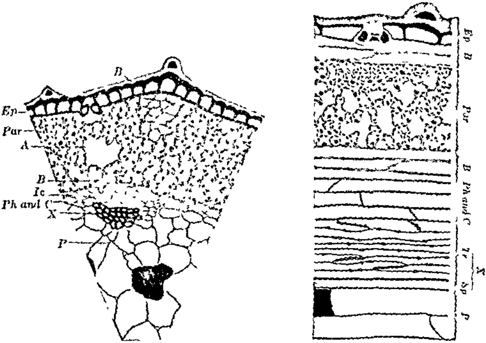


Fig. 44 —Transverse section of the stem of Ma Huang *Ep*, Epidermis with heavily cutinized outer wall, depressed stoma and an occasional cell with a slight projection forming a rib, cortex of thin-walled, spongy chlorenchyma (*Par*), an occasional air space (*A*), and a bundle of bast fibers (*B*), beneath a rib or associated with each of the small, open-collateral vascular bundles which contain a primary xylem (*X*) of spiral and dotted tracheal tubes and a secondary xylem of tracheids with bordered pits, *Ph and C*, phloem and fascicular cambium, *Ic* interfascicular cambium with starch granules, *P*, pith (After K K. Chen)

Ephedrine (U. S. P. 1936 to date) is an alkaloid obtained from *Ephedra equisetina* Bunge, *Ephedra sinica* Stapf and other species of *Ephedra*, or produced synthetically.

Description —Ephedrine occurs in white, rosette or needle crystals, or as an unctuous mass It is soluble in water, alcohol, chloroform, ether and in liquid petrolatum, the latter solution being turbid if the ephedrine is not dry.

Tests —Ephedrine melts between 34° and 40° C, depending upon the amount of water it contains, it contains not more than 0 1 per cent of ash, its solutions are alkaline to the usual tests for

Uses and Dose.— ing smooth and card epinephrine It pro and diminishes hype spray.

Ephedrine Hydrochloride (U. S. P. 1936 to date) $C_{10}H_{15}ON.HCl$, when dried over sulfuric acid for twenty-four hours, contains not less than 80 per cent and not more than 82.5 per cent of anhydrous ephedrine, $C_{10}H_{15}ON$.

Ephedrine Sulfate (U. S. P. 1936 to date), $(C_{10}H_{15}ON)_2.H_2SO_4$, when dried over sulfuric acid for twenty-four hours contains not less than 75.5 per cent and not more than 77.3 per cent of anhydrous ephedrine $C_{10}H_{15}ON$.

Both of these salts are readily soluble in water and in hot alcohol, but not in ether. They have the same pharmacological properties as ephedrine and are used orally in an average dose of 0.25 gm. They are also used, in aqueous solution, intramuscularly and intravenously.

ANGIOSPERMÆ OR ANGIOSPERMS

The Angiosperms are represented by at least 130,000 living species as compared with 650 species of Gymnosperms and 5000 species or less of Pteridophytes including the ferns.

The Angiosperms form the most recent development of plants. They did not occur in the Paleozoic age and but to a slight extent in the Mesozoic They are adapted to the land better than other great plant groups and are found in every part of the world where plants can live. They are distinguished from Gymnosperms by the following features: The stamens and pistils (carpels) are borne, frequently together, in flowers; the ovules are found in closed ovaries, the pollen is received on the stigma and the pollen nuclei are conveyed by means of pollen tubes to the ovule; tracheal tubes usually occur both in the primary and secondary xylem; many herbaceous annual or biennial forms occur, whereas Gymnosperms are all woody perennials.

MONOCOTYLEDONEÆ OR MONOCOTYLEDONS

This class of Angiosperms includes those plants in which the seed contains but one cotyledon. The stems are endogenous and contain concentric or closed collateral fibrovascular bundles. The leaves are usually parallel-veined and in the majority of cases have entire margins. The flowers are mostly trimerous.

GRAMINEÆ, OR GRASS FAMILY

These are mostly herbs with cylindrical, usually hollow stems (culms) closed at the swollen nodes. The leaves are alternate, the basal portion or sheath enveloping the culm and bearing at the orifice an appendage called the ligule. Under the epidermis of both stems and leaves there is a more or less strongly developed ring of sclerenchymatous fibers; similar fibers surround the fibrovascular bundles which occur in one or more circles beneath the endodermis when present.

The flowers are mostly hermaphroditic and are borne on spikelets. The axis of the spikelet is called a rachilla The lowest pair of bracts on the spikelet are called glumes and bear no flowers. The higher bracts each support a flower and are called lemmæ, palæ or flowering glumes. The fruit is a caryopsis. The family is of vast economic use, supplying the world with cereal grains, forage crops and other valuable products.

STARCHES

Probably no other single organic compound is so widely distributed in plants as is **starch.** It is produced in large quantities in green leaves as the temporary storage form of photosynthetic products. As a permanent reserve food material for the plant, it occurs in seeds and in

the pith, medullary rays and cortex of the stems and roots of perennials, etc. It constitutes from 50 to 65 per cent of the dry weight of cereal seeds and as high as 80 per cent of the dry matter of potato tubers.

In the United States alone, not less than 850,000,000 pounds of pure starch are marketed annually; of this amount almost five-sixths is made from Indian corn. While starch is widely distributed in the plant kingdom, there are relatively few plants from which it is obtained on

THE CHARACTERISTICS OF FIFTEEN RATHER COMMON STARCHES ARE

Starch	Botanical Source	Occurrence in cell	Shape*
Indian corn	*Zea mays*	Simple; may be united, but not in true aggregates	Polygonal or irregularly ovoid
Rice	*Oryza sativa*	Mostly round or oval aggregates of up to 100 grains	Polygonal or somewhat rounded
Wheat	*Triticum æstivum*	Large grains never united; small grains rarely	Large grains lenticular, small grains globular
Rye	*Secale cereale*	Similar to wheat	Similar to wheat
Barley	*Hordeum vulgare*	Similar to wheat	Similar to wheat, occasionally ovoid
Oat	*Avena sativa*	Mostly round or oval aggregates of many grains	Rounded, polygonal and spindle-shaped forms
Buckwheat	*Fagopyrum sagittatum*	A few rod-shaped aggregates	Polygonal or rounded polygonal
Potato	*Solanum tuberosum*	Aggregates rare	Ovoid, pyriform, ellipsoidal (oyster-shell forms)
Bermuda arrowroot	*Maranta arundinacea*	Aggregates rare or absent	Ovoid, pyriform, spindle-shaped
Kidney bean	*Phaseolus vulgaris*	Aggregates rare	Reniform, ovoid, ellipsoidal
Pea	*Pisum sativum*	Aggregates rare	Ellipsoidal, ovoid, subreniform
Cassava	*Manihot esculenta*	Numerous aggregates of 2 to 8 grains	"Kettle-drum" and "sugar loaf" shape; truncate
Sago	*Metroxylon* sp. *Cycas* sp	Some aggregates of 2 to 5 grains	Ovoid, irregular, plano-convex
Edible canna	*Canna edulis*	Aggregates rare	Broadly ellipsoidal, flattened, beaked
Sweet potato	*Ipomæa batatas*	Aggregates of 2 to 6 grains	Plano-convex, bell-shaped forms

* This applies to the simple grains and the components of the aggregates.

a large scale. In addition to corn, other cereals, as rice and wheat, contribute to the world's supply. Commercial starch is also obtained from potato tubers, maranta rhizomes and cassava roots

Starch occurs in granules (or grains) having characteristic striations. These striations and the size and shape of the granules are more or less characteristic in many species of plants and may be used as a microscopic means for identifying the botanical origin of the starch. In this manner

Classified in the Following Table (Also See Figs. 45 and 46)

Size in microns*	Hilum*	Striations*	Polarization*
10–35, mostly 20–30	Central, radiating clefts	Invisible	Distinct
2–10, mostly 3–7	Central, indistinct	Invisible	Distinct
Large 28–35, small 2–10	Central; dot, clefts rare	Indistinct	Indistinct
Large 25–60, small 3–10	Central, dot, occasional 3- or 4-rayed clefts	Concentric	Distinct
Large 18–30, small 2–10	Central, dot, occasional 3- or 4-rayed clefts	Concentric, indistinct	Distinct
Simple 2–12, mostly 5–10	Invisible	Invisible	
2–15, mostly 6–12	Central, conspicuous	Invisible	Distinct
2–115, mostly 45–70	Circular, at small end of grain	Distinct, eccentric	Very distinct
10–75, mostly 40–65	"Flying bird" hilum in broad end	Distinct, eccentric	Very distinct
25–60, mostly 30–45	Central, elongated branching cleft	Distinct, concentric	Distinct
15–55, mostly 20–45	Central, like bean, but less cleft	Distinct; concentric	Distinct, similar to bean starch
4–35, mostly 15–25	Central; distinct, often triangular, occasional clefts	Indistinct	Distinct
10–80, mostly 30–50	Eccentric, usually cleft	Concentric and eccentric	Distinct
18–135, mostly 50–100	Eccentric, dot near narrow end	Concentric and eccentric	Distinct
2–55, mostly 25–35	Distinct, usually slightly eccentric, occasional clefts	Indistinct	Distinct

* This applies to the simple grains and the components of the aggregates.

the identity of many food and drug products, of vegetable origin may be established.

General Properties of Starch.—The starches are substances of high molecular weight, whose constitution is represented by the general formula $(C_6H_{10}O_5)n$. The value of n has not been accurately determined for any of the individual members of the group but is probably somewhere in the neighborhood of 1500.

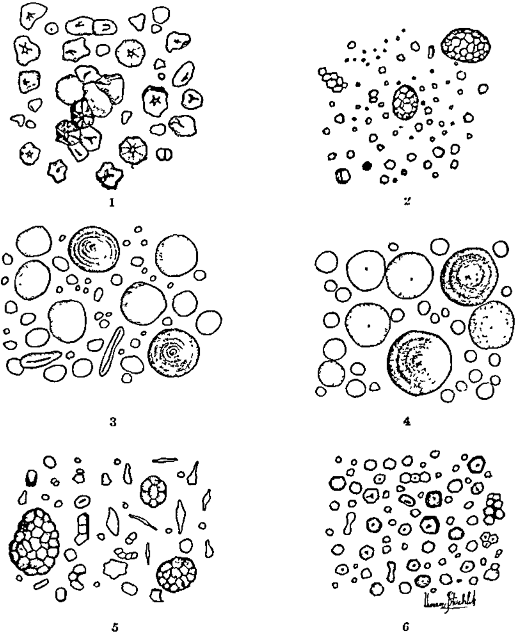


Fig 45.—Starches: 1, Corn starch; 2, rice starch; 3, wheat starch, 4, rye starch; 5, oat starch, 6, buckwheat starch. (Drawings by Vivian J. Stuchlik.)

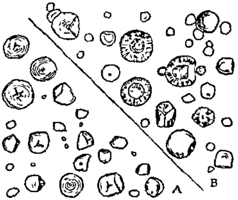
Starches generally form ... --lutions. If a suspen- ng water, the opaque If this is somewhat

concentrated, it will set to a firm jelly on cooling. Cold concentrated aqueous solutions of the caustic alkalis, of chloral hydrate, of ammonium thiocyanate,

7

8

9



10

11

12

[illegible] 9, bean starch; [illegible]

or of hydrochloric acid also cause the swelling and ultimate rupture of the starch granules to form pastes.

It is claimed th

are

in ... forming the slimy portion of the paste; and β-amylose (granulose or amylose) which is water soluble. These have been separated, to some extents by sedimentation, centrifugation, selective destruction of one component by

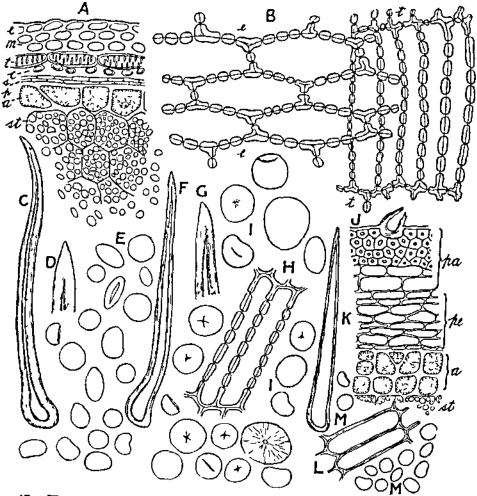


FIG. 47.—**Wheat** grain (*Triticum æstivum*) *A*, Transverse section showing epicarp (*e*), cells of mesocarp (*m*), tangentially elongated cells (*t*), tube cells (*c*), spermoderm (*s*), perisperm (*p*), aleurone cells (*a*), parenchyma containing starch (*st*); *B*, surface section of pericarp showing relation of epidermal cells (*e*) to tangentially elongated cells (*t*), *C*, hair from the summit of the grain with thick wall and very narrow lumen; *D*, apical portion of a hair; *E*, starch

tively ... h wall compara-

gential ... a hair; *H*, tan-

... walls; *I*, starch grains which vary from 0 020 to 0 070 mm. in diameter, and occasionally have delicate clefts. **Barley** grain (*Hordeum vulgare*) *J*, transverse section of palet (*pa*) and pericarp (*pe*), aleurone layer (*a*) composed of two or three rows of cells, parenchyma of endosperm containing starch (*st*); *K*, hair from epicarp with very thin wall and large lumen; *L*, tangentially elongated cells which differ from those of wheat and rye in being without pores; *M*, starch grains which resemble those of wheat but are uniformly smaller.

enzymatic action, or by other means. β-Amylose gives the characteristic blue

... action.

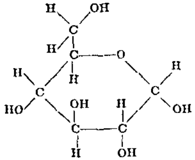
Amylases, such as diastase, hydrolyze starch to dextrins and these in turn to maltose which is the end product of diastatic action. Acids or maltase continue the hydrolysis to glucose. The various hydrolytic products have been given names and it has been suggested that the following scheme represents the progress of hydrolysis:

Starch → Amylodextrin → Erythrodextrin + Maltose
↓
Achroodextrin + Maltose
↓
Maltose
↓
Glucose

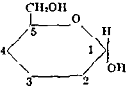
reaction starch will show its l-brown, and glucose gives no these color changes may mean arch particle, the diastase only distinct compounds, the color a depending upon the degree of dispersion.

unless the starch has been previously heated.

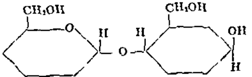
Chemistry of Starch.—If we assume glucose to exist in the pyranose form (I) we may then simplify the expression of its formula as illustrated in (II) and maltose may be expressed by formula III



I

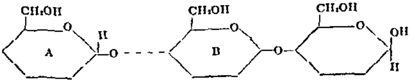


II



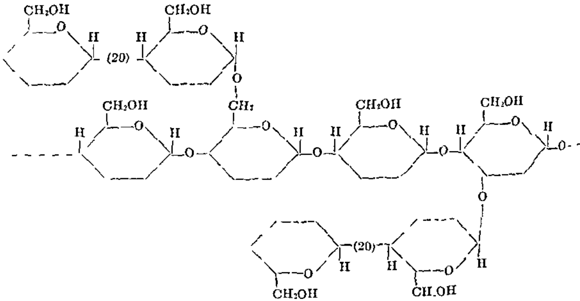
III

Applying methylation processes to maltose Haworth obtained both 2,3,6-tri-



IV

For every twenty to twenty-five glucopyranose units present in the chain (B) yielding 2,3,6-trimethylglucose there is one unit (A) present yielding 2,3,4,6-tetramethylglucose. Richardson suggested that some 1000 units comprised the chain. Staudinger demonstrated that starch was in reality composed of extremely large molecules (about 1500 glucopyranose units) and not simply aggregates of molecules. These large molecules appeared to be highly convoluted and Staudinger proposed the symmetrically branched configuration for starch shown in (V).



V

... ire of molecules Corn ... and about 30 per cent ... consists almost entirely of the type indicated in V.

Dextrin is a mixture of soluble carbohydrates, such as amylodextrin, achroodextrin and maltodextrin, together with a variable quantity of unconverted starch. It is prepared by partially hydrolyzing starch (see page 133). When dry starch is heated with steam at 180° to 200° C., **yellow dextrin** or **British gum** results

White Dextrin (N. F. 1916 to 1936; in culture media, N. F. 1936 to date) is formed from starch moistened with a very dilute mineral acid and heated to 110° C. The dextrins are chiefly prepared from corn starch in the United States and potato starch in Europe. Dextrin should be completely soluble in hot water and should not contain more than 5 per cent of dextrose (portion soluble in boiling alcohol), 10 per cent of moisture and 0.5 per cent of ash. Dextrin is used as an adhe... ...painting, etc.

etc ...

of the embryo, endosperm ...

Gluten (U. S. P. 1936 ... which becomes sticky when mixed with ... abundantly in wheat flour. The property of forming a dough is due to the gluten that flours contain.

Particles of the grains which cannot be milled fine enough to pass through the bolting cloths are separated and form what is commercially known as

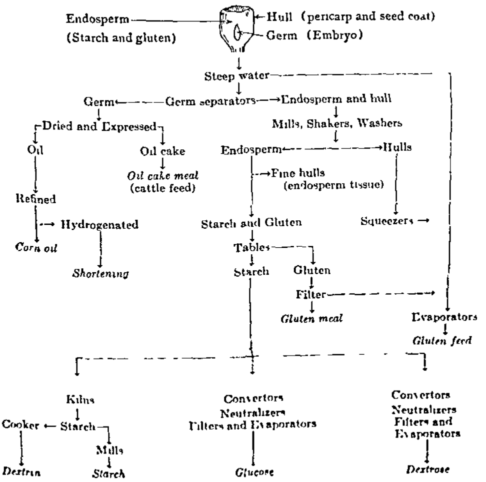
bran, middlings o usually the grains are first coarsely crushed, the coarser particles of the pericarp and seed

The flour is sifted out y fragments of tissue remain, which constitutes **middlings.** om the grain before making flour, as it contains considerable fat which readily becomes rancid and injures the quality of the flour. The germ is used to some extent urce of **Vitamin E.** y by the presence r, when moistened moistened, forms

If corn or any as **meal** or **grits.** as well as by the

Other Varieties of Zea Mays.—Among other varieties of *Zea mays* commonly occurring in commerce may be mentioned *Zea mays everta* to which belong the pop-corns; *Zea mays indentata*, the dent corns; *Zea mays indurata*, the flint corns; and *Zea mays saccharata*, the sweet or sugar corns.

GRAIN OF CORN

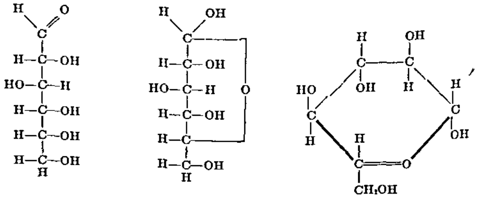


SUGARS

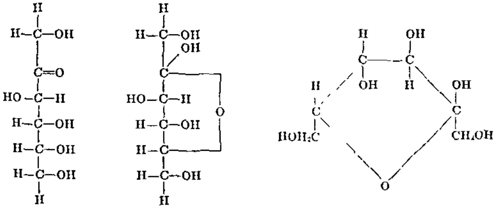
Sugars are simple carbohydrates and since they possess a characteristic sweet taste the term saccharide has been employed as a basis for the classification of this entire carbohydrate group. The monosaccharides include the hexoses, which are simple sugars having the formula $C_6H_{12}O_6$. The disaccharides, which may be regarded as being derived from the combination of two molecules of hexose with the dropping out of one molecule of water, have the formula $C_{12}H_{22}O_{11}$. The trisaccharides have the formula $C_{18}H_{32}O_{16}$.

Monosaccharides.—Chemically speaking, the definition of a simple sugar is a substance belonging to the carbohydrate group which is a ketonic or aldehydic substitution product of a polyhydric alcohol. The simplest of these would be a diose H.(CHOH).CHO, which although it does not occur in nature, probably enters into many plant syntheses. An aldehydic and a ketonic triose are possible (glyceric aldehyde and dihydroxy acetone), but do not occur free in nature, although certain organisms are capable of oxidizing glycerin to dihydroxy acetone. The tetroses also have not been found in nature. Pentoses however, occur c
gums a
found i
form tl
are 16
alpha and beta forms, permits 48 isomers. Of these, only 2 are found occurring in the free state in plants. They are levulose (fructose) and dextrose (glucose). Both are found in sweet fruits, honey and invert sugar. When starch is com-

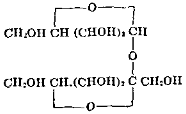
applied term "reducing sugars." The hexoses may be considered as six-membered open chain compounds, five of the carbon atoms each having an attached alcohol group and the sixth the aldehyde or ketone group. Such an aliphatic formula readily illustrates and explains stereoisomerism, but many of the other properties of the hexoses can only be explained on the basis of a ring structure. Thus glucose possesses an amylene-oxide ring. The following formulas have been assigned to glucose:



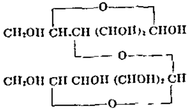
Fructose on the other hand may be represented as a straight-chain compound or as a butylene-oxide ring. The following formulas have been assigned to it:



Disaccharides.—Of the disaccharides, sucrose is the only member found occurring in the free state in plants, although maltose has been reported as occasionally present in the cell sap. Sucrose occurs in fruit juices, sugar cane, sugar beet, the sap of certain maples and in many other plants Upon hydrolysis it yields **invert sugar** which consists of molecularly equal quantities of dextrose and levulose. Sucrose is a non-reducing sugar and may be expressed by the following formula:



Malto[illegible] g in the free state in Nature, is produced in [illegible] s of starch during the germination of barley [illegible] ntation) It is a reducing sugar and upon [illegible] dextrose Maltose may be expressed by the following formula.



The four sugars mentioned (dextrose, levulose, sucrose and maltose) are those most commonly occurring in vegetable drugs. Certain other sugars, however, occur to a limited extent in Nature, either in the free state or in glycosidal combination. Among these are the monosaccharides, mannose (occurring in mannosans) and galactose (a constituent of lactose and raffinose), and the disaccharides trehalose (which is found widely distributed in the fungi) and lactose (milk sugar). Maltose and lactose possess functional aldehyde groups and so are reducing sugars. Sucrose and trehalose are non-reducing sugars

Microchemistry of the Sugars.—Although sugars are easily soluble in water and occur in solution in the living cell, it is very seldom that they crystallize upon the drying of plant material. If the dry plant material be extracted with water the sugar will dissolve and may be identified by certain microchemical reactions, among which the following are useful:

The Molisch Reaction.—Mix about 5 drops of the aqueous extract with 2 drops of a 15 per cent solution of α-naphthol in alcohol, preferably in a small white porcelain evaporating dish or on a spot-plate. Add an equal volume of concentrated sulfuric acid and agitate. The presence of sugar is indicated by a deep violet color. Dilution with water will cause the separation of a bluish violet precipitate which is soluble in ether or alcohol with a yellow color; in potassium hydroxide T.S. with a yellow color; and in ammonia, yellowish brown droplets are formed.

The reaction is not specific for sugars, as other carbohydrates (inulin, starch, ... bable that the ... s, which sugar ... ited in 1 drop ... and the whole is covered with a cover-... hydrates react within two minutes. ... several minutes and occasionally one-...

If the above reaction is carried out using a solution of thymol instead of α-naphthol a brick-red to carmine-red color will be obtained.

The Fluckiger Reaction.—Of the ... of what is commonly known as the Fehling re... ably the most satisfactory. A smal... a few drops of 15 per cent sodium ... introduced (or a drop of the aqueous extract added) and covered with a cover-glass.

Levulose, if present, will cause the precipitation of reddish yellow copper oxide without heating, the precipitate being well localized (in sections). The application of a very little heat will result in further precipitation if dextrose is present If sucrose is present prolonged heating will cause its change to invert sugar, with the consequent further precipitation of copper oxide.

Wh... useful reaction it must be bo... (some tannins, phenols, etc.)

The Phenylhydrazine Reactions.—Two reagents are prepared as follows: (1) Phenylhydrazine hydrochloride in glycerin 1 to 10. (2) Sodium acetate in glycerin 1 to 10 One dr... mixed ... the section (or a drop of ... covered with a cover-glass ... levulose, if present, will ... hours. Dextrose will form its osazone only after one or more days, while sucrose will form no osazone unless the preparation is heated.

If, for example, a preparation which has remained at room temperature ... or thirty to forty minutes on the ... thereby indicated. (The phenyl- ... ough to invert the sucrose) If crystals form ... of crystals is obtained upo... is indicated.

If heat is ... llization will proceed much more rapidly.

With sections, however, this is disadvantageous, as the carbohydrates will migrate, and not remain localized in their original cells. If heat is used at the beginning of the reaction, no differentation between dextrose, levulose and

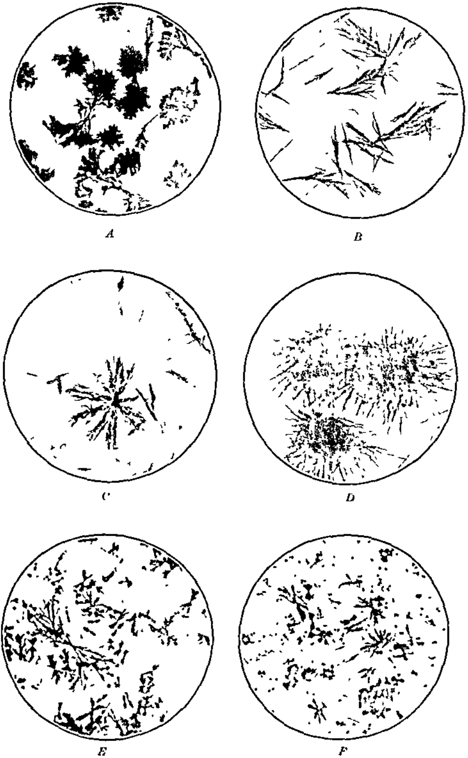


FIG. 48.—Photomicrographs of A, Glucosazone, B, Fructosazone, C, Maltosazone; D, Lactosazone, E, Osazones from honey, F, Osazones from date

sucrose can be made. The osazone crystals usually occur as sphæro-crystals,
es or in star formation (see Fig. 48). Senft,
as able to obtain osazones from fruits and
be kept as permanent mounts in glycerin-jelly.

Care should be exercised in interpreting result
heat is employed they may be hydrolyzed. In s
indicate the presence of hexoses as such in the
tion. It should be noted, also, that in the prc
apparently some enzymatic action which will bring about the hydrolysis of glucosides, if present.

Graefe has developed an interesting method for the detection and differentiation of sugars in plant tissue. He found that secondary asymmetrical methyl-phenylhydrazine will give osazones only with the ketoses. The reaction is thus a specific one for levulose. By combining the results of both reactions, the presence or absence of certain sugars may be readily determined

Dextrose, levulose and sucrose are the only sugars occurring free in plant tissues Maltose, which is only found in rare cases, is a reducing sugar, reducing Fehling's solution but not as easily as glucose. It forms osazones with phenyl-hydrazine but not with methyl-phenylhydrazine. Upon hydrolysis it yields dextrose which may be determined by the above methods. Lactose, which is considered under the section on "Animal Drugs," reduces Fehling's solution and forms an osazone.

The Barfoed Test.—This test is used to distinguish between mono- and disaccharides Two or three drops of the reagent consisting of cupric acetate, 13.3 gm , glacial acetic acid 1.8 cc. and distilled water, 200 cc is placed on the slide which is then transferred to the water bath. Place the section (or drop of the aqueous extract) in the drop noting the time of the addition Again note the time of the first formation of a reddish brown precipitate. At the same time prepare and process a blank slide having only the reagent.

Solutions of galactose, dextrose or levulose afford strong precipitates, usually within one and a half to two minutes. Maltose and lactose may show some precipitation in about four minutes, while sucrose remains negative for ten minutes or more.

The Seliwanoff Test.—This test is used to indicate the presence of ketose
lose sugars. One to two
in 100 cc. of HCl (1 to 2)
lution (1 to
2 drops) are added and the time c lso
be run and a white background the
color. Note carefully the time of appearance of the first rose-pink color.

Fructose (10 per cent solution) produces a rose-pink color in thirty to forty-five seconds Sucrose produces the same color in fifty to seventy-five seconds; requiring this additional time for hydrolysis. Glucose and maltose may produce faint pink colors in from three to four minutes, while lactose is usually negative after five minutes The ketose is converted into levulinic acid and hydroxy-methyl-furfural, this latter compound condensing with the resorcinol to form the red-colored compound.

The Mucic Acid Test.—This test is used to demonstrate either lactose or galactose or both; alone or in mixtures. To 1 cc. or less of the sugar solution in a small test-tube, add an equal volume of concentrated nitric acid, stopper the tube and allow to stand for twenty-four hours. Lactose or galactose undergo oxidation to mucic acid, which slowly precipitates in crystalline form which may be identified microscopically.

Glucose and fr disaccharides are
oxidized to the iso Better results
are sometimes obtr ieating the test-
tube carefully to l iours.

STARCH OR AMYLUM

The following kinds of starch have been recognized in the U. S. Pharmacopœia and/or in the National Formulary:

- Cassava or Tapioca (U. S. P. 1820 to 1882). (See pages 402, 403.)
- Sago (U. S. P. 1820 to 1882). (See page 148.)
- Maranta (U. S. P. 1820 to 1882; as reagent, U. S. P. and N. F. each 1936 to date). (See page 185.)
- Wheat (U. S. P. 1842 to 1894; as reagent, U. S. P. 1882 to 1894) (See pages 120, 122, 124.)
- Canna (U. S. P. 1863 to 1882). (See page 120.)
- Potato (as reagent, U. S. P. 1882 to date) (See pages 120, 123.)
- Corn (U. S. P. 1894 to date; as reagent, U. S. P 1894 to 1916).

Wheat Starch and Corn Starch were defined until 1916 as "the fecula of the seed;" since then Corn Starch has been defined as the "grains or granules from the fruit or the grain of *Zea mays* Linné."

Zea mays is native to America, and Indian Corn has been found in the tombs of the ancient Peruvians and in the mounds of the Aztecs of the Mississippi Valley. Columbus took samples of corn to Spain on his return in 1502 and within a very short time it spread over southern Europe, northern Africa and western Asia. The central United States produces the greatest quantity of our domestic supply, Illinois and Iowa leading in this production.

PREPAR[illegible] hours in warm [illegible] The softened [illegible] which loosen th[illegible] At this point the germ (embryo [illegible] the oil. The endosperm is furthe[illegible] starch and gluten slurry washed away from the non-friable hulls on sieves made of silk bolting cloth into long, slightly inclined, wide-bottom troughs, the starch settles to the bottom and the gluten forms a layer on top. Repeated treatments with cold water give a starch free from practically all gluten. Such starch is known as acid-washed and constitutes almost wholly the corn starch of commerce The starch is allowed to settle from the last wash water or is filter-pressed and is then dried

DESCRIPTION.—See pages 120, 122, and 123 and the U. S. Pharmacopœia

STANDARDS AND TESTS —Starch is colored a deep blue by iodine T S. One gram of starch boiled with 15 cc of distilled water and subsequently cooled results in a translucent, whitish jelly. Starch should contain only a trace of foreign organic matter, should yield not more than 0.5 per cent of ash and not more than 14 per cent of moisture.

USES.—Starch is a nutrient, demulcent, protective and absorbent. It has been used externally to allay itching in erysipelas and urticaria. A starch suspension may be swallowed as an antidote to iodine poisoning It is used pharmaceutically as a dusting powder and as a diluent for powders. Glycerite of starch is used as an emollient and as a base for suppositories. Starch has many commercial uses such as paper sizing, cloth sizing, laundry starching, etc. It is the starting product from which glucose (corn syrup), dextrose and dextrins are made.

SUGARS

The following sugars have been recognized in the U. S. Pharmacopœia and/or in the National Formulary:

Glucose (U. S. P. 1916 to date).

Dextrose (U. S. P. 1926 to date; in culture media, U. S. P. 1916 to date; N. F. 1926 to date).

Arabinose (in culture media, N. F. 1936 to date).

Xylose (in culture media, N. F. 1936 to date).

Rhamnose (in culture media, N. F. 1936 to date).

Mannitol or Manna Sugar (in culture media, N. F. 1936 to date).

Sucrose or Saccharum (U. S. P. 1820 to date; as reagent, U. S. P. 1926 to date; N. F. 1936 to date).

Maltose (in culture media, N. F. 1936 to date).

Lactose (U. S. P. 1863 to date; in culture media, U. S. P. 1916 to 1926, 1942 to date; N. F. 1926 to date).

Galactose (in culture media, N. F. 1942 to date).

Dulcitol or Dulcose (in culture media, N. F. 1936 to date).

The three latter items are derived from milk, and are described on pages 687 to 688.

Liquid Glucose or Glucose is a product obtained by the incomplete hydrolysis of starch. It consists chiefly of dextrose, maltose, dextrins and water.

In the United States, Liquid Glucose is usually made from corn starch (see page 133). The washed starch is mixed with diluted hydrochloric acid and heated for twenty-two minutes at about 30 pounds pressure; the acid is neutralized; the neutral liquid centrifuged and filtered until clear; then evaporated to the syrupy condition.

It is unfortunate that the name "glucose" has also been applied to pure dextrose.

Description and Properties.—A colorless or yellowish, thick, syrupy liquid; nearly odorless, taste sweet. For Tests of Identity and Purity see the U. S Pharmacopœia.

Uses.—Glucose is a food and is employed as a sweetening agent, as a substitute for sucrose in syrups, and as an excipient for pills

Dextrose or d-Glucose is a sugar usually obtained by the hydrolysis of starch. It occurs naturally in grapes and other fruits and may be obtained from these sources [illegible] of certain natural glucosides It is usual [illegible] glucose; the conversion takes [illegible] for about thirty-five minutes. The sugar is crystallized, washed and dried to yield a dextrose of 99.5 to 100 per cent purity.

Description, Constants and Tests of Identity and Purity.—See the U. S. Pharmacopœia

Uses.—Dextrose is a food and may be given by mouth, by enema, by subcutaneous or by intravenous injection It is used commercially in the manufacture of candy, carbonated beverages, ice cream, bakery products, and in the canning industry.

Calcium Gluconate (U. S. P. 1936 to date) is the calcium salt of gluconic acid. Gluconic acid is obtained by the oxidation of dextrose, either with chlorine, or electrolytically in the presence of a bromide, or by fermentation. Calcium gluconate is soluble in cold water and is less irritant for intramuscular use than calcium chloride. It is used to obtain the therapeutic effects of calcium.

Calcium Levulinate (N. F. 1946 to date) is the calcium salt of levulinic acid. Levulinic acid is prepared from starch or from cane sugar by boiling with hydrochloric acid. The salt is very soluble in water. It is used in subcutaneous injections to obtain the therapeutic effects of calcium.

Levulose, d-Fructose or F ... most,
sweet fruits, and in honey.
when it is formed in equal
inulin. It is freely soluble in water, alcohol or acetone and has a specific rotation of $-93°$. It is used as a food for diabetics and in infant feeding formulas.

Arabinose, l-Arabinose or Pectin Sugar is a pentose obtained from gums such as acacia, mesquite or cherry gum, by boiling the gum with diluted sulfuric acid, thus partially hydrolyzing the arabans present.

... the **Proper-**
tie

Xylose, l-Xylose or Wood Sugar is a pentose and is obtained by boiling corn cobs, bran, straw or similar material with dilute acid to hydrolyze the xylans present.

It is colorless, odorless, crystallizable into needles and has a sweet taste For the **Properties and Tests of Purity** see the National Formulary, Reagent section.

Xylose is very difficult to ferment; it is used for the detection or identification of a certain few, rare species of bacteria, which do ferment it

Rhamnose, Hydrous l-Rhamnose, Isodulcite or Isodulcitol is a methyl pentose, $C_6H_{12}O_5H_2O$, obtainable from certain glycosides, such as quercetrin, and which are known as rhamnosides.

Rhamnose occurs as colorless, odorless, sweet crystals or a crystalline powder readily soluble in water. The specific rotation of the aqueous solution of the sugar is at first levorotatory ($-7°$) but soon becomes slightly dextrorotatory ($+8.5°$ to $+8.6°$).

Properties and Standards of Purity.—See the National Formulary, Reagent section.

Rhamnose is used as a fermentative reagent in bacteriological culture media

Mannitol, Anhydrous d-Mannitol, Mannite or Manna Sugar is a hexahydric alcohol obtained from manna or by reduction of mannose. Mannose is a hexose made commercially by hydrolysis of the waste turnings of ivory nuts (vegetable ivory).

Mannitol occurs as a colorless, odorless, sweet powder or in minute crystals It is soluble in water, reduces Fehling's solution and is fermented by yeast.

PROPERTIES AND TESTS FOR PURITY.—See the National Formulary, Reagent section.

Mannitol is used as a fermentative reagent, as a mild laxative, as a diabetic food and, industrially, in plastics and artificial resins.

Sucrose, Saccharum or Sugar is obtained from sugar cane, *Saccharum officinarum* Linné; sugar beet, *Beta saccharifera* (*vulgaris* Linné) and other sources.

Sucrose is widely distributed in plants, and, commercially, is obtained on a small scale from the sugar maple (*Acer saccharum*, Fam. *Aceraceæ*), from various palms and other sources. Cane sugar is produced in Cuba, Puerto Rico, Louisiana, Philippines, Hawaii, Java and India, while beet sugar is largely produced in Germany, Austria, Russia, France and the United States. The enormous total production of the world is about equally divided between sugar cane and sugar beet.

Sugar cane is native to India, being introduced into Europe by the Venetians during the crusades. During the fifteenth and sixteenth centuries it found its way into most European colonies in the tropics.

PRODUCTION.—The juice is obtained from sugar cane by crushing the stems between series of heavy iron rollers. It is boiled with lime to neutralize the plant acids (these acids would change the sucrose to invert sugar) and to coagulate albumins. The latter rise to the top as a scum and are removed. The juice is filtered, sometimes decolorized with sulfur dioxide, concentrated and crystallized; when crystals of sugar are no longer obtainable, the residual dark-colored syrup is **Molasses** (U. S. P. 1863 to 1873), which is extensively used in foods, prepared animal foods and in [illegible] of ethyl alcohol.

DESCRIPTION AND PROPERTIES.—See [illegible] ation in

USES.—Sugar is a demulcent and a [illegible] it is aqueous solution it is bacteriostatic [illegible] used in syrups and other agreeable [illegible] the masking of disagreeable tastes in [illegible] of oxidation in certain preparations of iron.

Maltose, Hydrous Maltose or Malt Sugar is a disaccharide obtained by the partial hydrolysis of starch, usually by means of diastase.

Maltose occurs as colorless, odorless, sweet crystals or a white powder, and is very soluble in water. It is dextrorotatory and is fermented by yeast.

PROPERTIES AND STANDARDS OF PURITY.—See the National Formularly, Reagent section.

Maltose is used as an easily digested nutrient, especially in the form of malt extract (see page 138); as a sweetener and as a fermentative reagent.

Caramel or Burnt Sugar Coloring (N. F. 1916 to date) is a concentrated aqueous solution of the product obtained by heating sugar or glucose until the sweet taste is destroyed and a uniform dark brown mass results, a small amount of alkali or alkali carbonate being added while heating.

DESCRIPTION.—Caramel is a thick, dark brown liquid having the characteristic odor of burnt sugar and a pleasant, bitter taste. The specific gravity is not less than 1.30 at 25° C. Caramel mixes with water in all proportions and with aqueous alcohol, having an alcoholic content of less than 80 per cent. One part in 1000 of distilled water yields a clear solution having a distinct sepia tint. Spread in a thin layer, caramel should appear homogeneous, reddish

rown and transparent. It should give no precipitate with phosphoric acid nd yields not more than 8 per cent of ash.

USES.—Caramel is used in coloring certain pharmaceutical preparations

ALCOHOL

Alcohol, Ethanol or Spiritus Vini Rectificatus (U. S. P. 1820 to date) s a liquid containing not less than 92.3 per cent by weight, corresponding o 94.9 per cent by volume, at 15.56° C., of C_2H_5OH.

Dehydrated Alcohol or Absolute Alcohol (U. S. P. 1894 to 1946; N. F. 946 to date; in reagents, U. S. P. 1882 to date) is a liquid containing not less than 99 per cent by weight of C_2H_5OH.

Whiskey or Spiritus Frumenti (U. S. P. 1863 to 1916, 1926 to 1946, N. F. 1946 to date) is an alcoholic liquid obtained by the distillation of he fermented mash of wholly or partly malted cereal grains, and containing not less than 47 per cent and not more than 53 per cent, by volume at 15.56° C., of C_2H_5OH. It must have been stored in charred wood-containers for a period of not less than two years.

The natural processes of fermentation have been utilized since earliest historical times f … Fermented beer from grain s mentioned … B C), and fermented grape uice or wine … imes. Natural fermentation can hardly produce a concentration of alcohol in the fermenting liquid exceeding 14 per cent by volume, because the fermentative organisms are inhibited at such a concentration.

The process of distillation by which the alcohol in the fermented liquid can be concentrated in the distillate was not known until perhaps the eighth century A D

Only in very modern times has the process been so perfected that very pure alcohol could be obtained. By distillation, brandy from wine, whiskey from …

U. S. Pharmacopœia or the National Formulary under each of the above titles.

OTHER CORN PRODUCTS

Corn Oil (U. S. P. 1936 to 1942; 1947 to date) is the refined, fixed oil expressed from the germ of *Zea mays* Linné.

After the cracked corn leaves the attrition mills (see preparation of *Amylum* …

ground and sold as cattle feed (**oil cake meal**). The crude oil is clarified by filtering and settling, and refined by removing the fatty acids, refrigerating, filtering and sterilizing. …

Corn oil is a clear, l… and taste. It is slightl… benzene and petroleun… and 0.921 at 25° C.; … tain not more than 2 per cent of … n 10 gm. of corn oil should require … de for neutralization and the corn

Corn oil is used as a solvent for irradiated ergosterol and as an emollient. It is an edible oil, and as such is used in salads and cookery. When hydrogenated, the oil becomes semisolid, useful as a shortening in cookery.

Cornsilk or Zea (U. S. P. 1894 to 1905; N. F. 1916 to 1946) consists of the fresh styles and stigmas of *Zea mays* Linné. The styles and stigmas should be collected when the corn is in milk and should be used in the green condition for the manufactu[illegible]

Styles, slender, [illegible] ish white, more or less transl[illegible] to 3 mm. long; odor slight; [illegible]

Styles consisting for the most part of parenchyma and two parallel vascular bundles with narrow, spiral, or [illegible] frequently extended into multi[illegible] the basal portion consisting of [illegible] unicellular; the cells of the hairs are rich in cytoplasm, and each contains a [illegible]

See the National Formulary for standards and tests.

Cornsilk is a diuretic. Average dose, 4 gm.

BARLEY

Barley is the dried grain of one or more varieties of *Hordeum vulgare* Linné. Barley is grown throughout the world wherever the climate is favorable.

Malt or Malted Barley (U. S. P. 1882 to 1894, 1905 to 1936; N. F. 1894 to 1905) is dried, artificially germinated barley grain. To prepare malt, barley grain in heaps in a warm room is kept wet with water and allowed to germinate until the caulicle protrudes. The grain is then quickly dried. The enzyme diastase in the moist warm grains acts to convert the starch to maltose, which stimulates the embryo to growth, and which is killed when the grain is dried.

Dry malt resembles barley, but is more crisp, with an agreeable odor and a sweet taste. It contains 50 to 70 per cent of the sugar, maltose; 2 to 15 per cent of dextrins; 8 per cent of proteins; diastase and a peptase enzyme. Malt yields not less than 70 per cent of dry extract to an aqueous infusion at 50° to 55° C.

Malt is used very extensively in the brewing and alcohol industries. Malt Extract is used medicinally.

Malt Extract (U. S. P. 1882 to 1894, 1905 to 1946; N. F. 1894 to 1905, 1947 to date) is prepared from malt by infusion at 60° C. or less and subsequent concentration at a temperature not exceeding 60° C. Ten per cent by weight of glycerin is added to the extract, which in finished form contains dextrin, maltose, a small amount of glucose, and diastase.

Malt Extract is capable of converting not less than five times its weight of starch into water-soluble sugars.

Malt Extract is used as an easily digested nutritive and as an aid in digesting starch. The average dose is 15 gm. Many commercial extracts of malt contain no diastase, this ferment having been destroyed by the heat used for their sterilization. Such extracts should not be confused with the U. S. P. product.

Diastase (U. S. P. 1916 to 1926) is a yellowish white amorphous powder obtained from an infusion of malt and capable of converting fifty times its weight of potato starch into sugars. Taka-Diastase is a kindred product claimed to convert three hundred times its weight of starch into sugars.

Pearl Barley or Hordeum (U. S. P. *1820 to 1882*) is the entire barley grain from which most of the pericarp and seed coat have been removed by passing between two rough *revolving plates. Pearl Barley* and **Barley Flour** are used as nutrients and demulcents in cases of subnormal digestion.

OAT

Avena or Oat (N. F. 1926 to 1947) is the grain of *Avena sativa* Linné. The plant ...

1 5 cm in length and about ... mm. in diameter, tapering toward each end, the lemma surrounding the grain except on the ventral side where there is a distinct longitudinal groove outer surface of the lemma glabrous with five or more longitudinal veins on the *dorsal surface;* within the groove a narrow, thinly membranous, two-veined *palet or scale.* The fruit or naked grain tapers toward either end, at the micropylar end occurs a wart-like excrescence or caruncle, at the opposite end a dense mass *of long* slender hairs which also occur, though less abundantly, over the surface of the fruit.

Powdered oat is whitish with a slight odor and a starchy taste It shows *fragments of* epicarp with thin-walled cells up to 400 microns in length, with some of the cells extended as slender pointed hairs up to 2 mm. in length and 20 *microns* in diameter at the base; palet epidermis fragments with coarse unicellular ...

or ellipsc

60 *micro*

up to 10 microns in diameter.

Oat contains about 43 per cent of starch; a protein, avenin; small amounts of *sugar,* gum, cellulose, and inorganic salts; total ash about 3 25 per cent, acid-insoluble ash about 1.6 per cent.

Oat is a stimulant and a nutrient.

Avenæ Farina or Oatmeal (U. S. P. 1820 to 1882) is the oat grain deprived ... the grain

suitable for *convalescents.*

RICE POLISHINGS

Rice Polishings, Rice Bran, or Tikitiki (U. S. P. 1942 to date) consist of the fine, flaky pericarp and spermoderm fragments, the embryo, aleurone layer and outer adhering cells of the starchy endosperm of the grain of *Oryza sativa.* Oryza is Greek meaning rice and sativa is from the Latin *sativus* meaning that which is planted, thus indicating cultivated rice. Rice is ... extensively cult ... It is also cult ... The rice is hulled between stones, the resulting product being known as "brown rice," which ... The brown rice is decorticated ... od product found on the market. ... this latter operation.

It has long been observed that an exclusive diet of polished rice resulted in the *deficiency* disease, beriberi. The fact that rice polishings when fed to pigeons with beriberi cured the disease demonstrated that a necessary dietary factor

was removed in the polishing process. We now know this to be Vitamin B_1 and probably other members of the B-complex (see page 669). Most of the vitamin content is located in the aleurone layer. Rice polishings are included in the U. S. Pharmacopœia largely because of their use in Philippine medicine. (The U. S. P. is the official Pharmacopœia of the Philippines.)

Description, Physical Properties, Histology and Identity.—See the United States Pharmacopœia.

Standards and Tests.—Not more than 10 per cent remains on a 30-mesh sieve, indicating a 10 per cent limit on rice hulls. It contains not more than 40 per cent of rice starch, which is determined by the cuprous oxide method.

Rice Polishings Extract (U. S. P. 1942 to date) is a liquid hydroalcoholic extract of rice polishings. One cubic centimeter contains not less than 20 U. S. P. units of Vitamin B_1 and represents approximately 14.5 gm. of polishings. Dose, 8 cc.

TRITICUM

Triticum, Couch Grass or Dog Grass U. S. P. 1882 to 1926; N. F. 1926 to date) consists of the dried rhizome and roots of *Agropyron repens* (Linné) Beauvois. *Agropyron* is from the Greek *agros*, a field, and *pyros*, wheat; *repens* means creeping. The drug was employed to a considerable extent by the ancients as a remedy for urinary disorders. The plant forms slender, jointed rhizomes, by means of which it is extensively propagated.

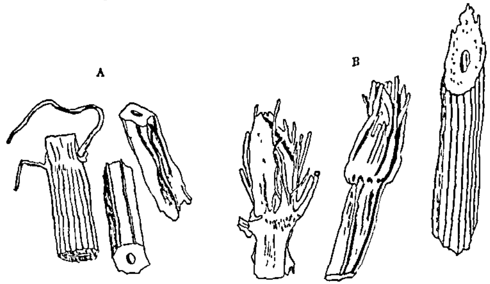


Fig. 49.—Pieces of (*A*) commercial Triticum, and (*B*) commercial Bermuda Grass sold as Triticum. Enlarged to show the roots attached at the nodes and the markings on the rhizomes. Bermuda Grass tends to be thicker. (Drawings by E. N. Gathercoal)

The rhizome is gathered in spring, usually deprived of the rootlets, cut into pieces and carefully dried. The commercial supplies come chiefly from central Europe, where the plant is indigenous. It has, however, been naturalized in North America.

Description, Structure and Powder.—See Figures 49, 50 and 51 and the National Formulary.

CONSTITUENTS.—Triticin, a lævorotatory carbohydrate resembling inulin, 8 per cent; dextrose and levulose 2.5 to 3.3 per cent, a nitrogenous, gummy substance 11 per cent; acid malates; from 1.85 to 5.2 per cent of total ash and from 0.7 to 1.9 per cent of acid-insoluble ash consisting chiefly of silica from

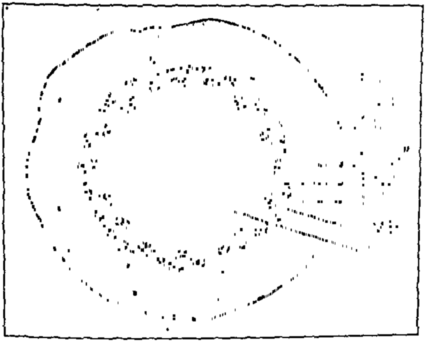


FIG. 50.—Transverse section through the rhizome of *Agropyron repens* (Triticum) *Ep*, epidermis; *Hyp*, hypodermis, *Co*, cortex, *End*, endodermis, *S R*, sclerenchyma ring, *F.V.B.'*, fibrovascular bundle, *F.V B ''*, root trace fibrovascular bundle *P*, pith (Photomicrograph by R. S. Adamson.)

USES AND DOSE.—Triticum is a demulcent and diuretic. Average dose, 10 gm

ADULTERANTS —The rhizomes of various *Carex* species have been reported as adulterants of triticum They contain starch.

The rhizome of *Capriola dactylon* known as **Bermuda Grass** or **Dog Grass** has been substituted for triticum. It may be distinguished from triticum by many characteristics.

Vetiver, Radix Iwarancusæ or Cuskus Root is the rhizome and roots of *Andropogon squarrosus*, a perennial grass indigenous to the East Indies and cultivated in tropical America and in greenhouses in the United States. The rhizome is short and thick, bearing numerous long, cylindrical, tortuous roots; color, reddish brown; odor, aromatic. A small amount of viscid, dark volatile oil is present, which possesses an intense and very persistent odor, being used ... The commercial ... ered vetiver with

... species growing in Brazil and Persia have app ... vetiver.

Citronella Grass, *Andro* ... lon and Java and in Florida and C ... ports of

this oil into the United States ...
per year ...
of 0.89 to ...
in perfume ... for soaps. In the form of a spray or by application to the skin it is of value as a protection against mosquitoes and similar insects.

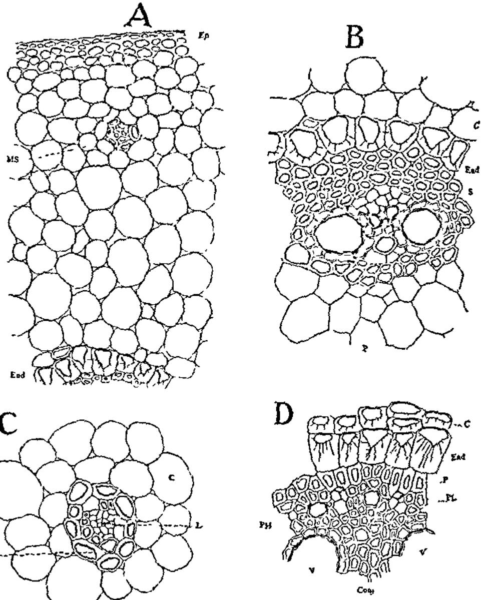


FIG. 51.—Triticum. A, transverse section of a rhizome or stolon, *Ep*, epidermis; *MS*, a vascular bundle situated in the cortical parenchyma, *End*, endodermis. B, continuation of section figured in A showing cortical parenchyma (*C*), endodermis (*End*), sclerenchymatous fibers or stereome (S) ... having porous w... large tracheæ ... chyma cells of p... in them; paren- showing that it ... the cortex (C) ... earliest vessels are developed, *V*, portions of two tracheæ; *Conj*, thick-walled conjunctive tissue. (After Holm.)

Sleepy Grass, *Stipa vaseyi*, grows throughout Mexico and the southwestern part of the United States and possesses the property of causing sleep in any animal that has eaten it. Its marked depressing action on the vital functions of the body obviates the possibility of utilizing its hypnotic properties

PALMÆ, OR TRUE PALMS

These are mostly shrubs and trees restricted to tropical and subtropical countries. They were at one time quite extensively distributed and very numerous, and at the present time they are represented by about 140 genera and some 1200 species. The trees often reach the height of 100 feet, without branches, and bear at the summit a cluster of large leaves which are either pinnate (feather palms) or palmate (fan palms). The low-growing palms, as the saw palmetto of the southern United States, may have a creeping and branching rhizome. The flowers of palms are produced in the axils of the leaves and are usually unisexual and regular. The carpels may be free or united and develop into a berry (date), drupe (coconut) or nut (betel nut). The seeds have a large endosperm, the cell-walls of which are much thickened with cellulose, as seen in the date and vegetable ivory. The stem consists of an epidermal layer, with silicious walls, and numerous fibrovascular bundles of the concentric type, embedded in parenchyma, so as to form a rather dense woody portion. The palms are of importance to man, being employed for a large number of purposes.

SERENOA

Serenoa, or Saw Palmetto Berries (U. S. P. 1906 to 1916; N. F. 1926 to date) is the partially dried, ripe fruit of *Serenoa repens* (Bartram) Small. The generic name *Serenoa* is given in honor of Professor Sereno Watson, of Harvard; *repens* is Latin signifying "creeping"; that is, producing new plants at a distance from the parent plant; "palmetto" is from the Spanish *palmito*, signifying a small palm tree.

The saw palmetto is a low, scrubby palm found growing from South Carolina to Florida. In some places along the Florida coast the jungles are so thick and the saw-like leaves so dense as to be almost impenetrable. The inflorescence is densely tomentose and shorter than the leaves. The fruit is a 1-seeded drupe (see Fig. 52).

The fruits are partially dried to a prune-like consistence. Some are packed directly in alcohol, which is later employed as a menstruum for their extraction and others are packed in casks, being protected from insect attacks with chloroform or carbon tetrachloride.

Description, Structure and Powder.—See Figure 52 and the National Formulary.

[illegible]

Sta[illegible] of foreign organic matt[illegible] [illegible]ble ash. Serenoa

should contain from 10 to 15 per cent of natural moisture when used for the manufacture of pharmaceutical preparations.

USES AND DOSE.—Serenoa is a diuretic, sedative and anticatarrhal. Average dose, 1 gm.

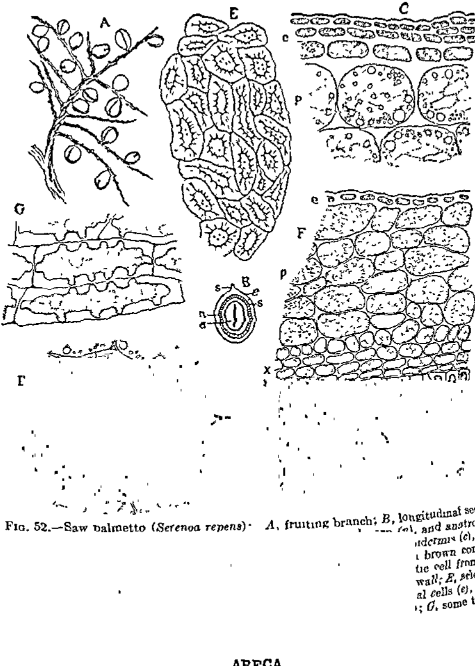


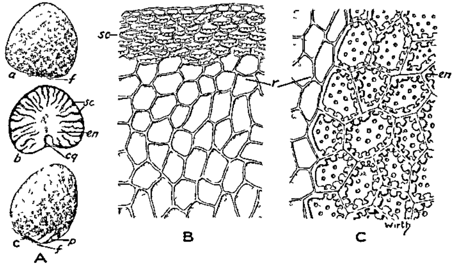
FIG. 52.—Saw palmetto (*Serenoa repens*). *A*, fruiting branch; *B*, longitudinal section ... (e), and anatropous ... idermis (c), sub- ... brown content, ... tic cell from the ... wall; *E*, sclerotic ... al cells (e), large ... ; *G*, some thick-

ARECA

Areca, Areca Nut or Betel Nut (N. F. 1936 to date) is the dried ripe seed of *Areca catechu* Linné. *Areca* is the Spanish and Portuguese term for the betel nut. *Catechu* is the East Indian name for an astringent extract or juice. *Areca catechu* is a beautiful tall palm extensively cultivated in India, southeastern Asia, in the East Indies and to some extent in east Africa. The fruit is a nut containing a single seed with a thin seed coat and a large ruminate endosperm. The seeds are removed

from the fruits, boiled in water containing lime, and dried. The principal points of export are Ceylon, Singapore, Penang and Madras.

Areca is mixed with lime, the leaves of *Piper betle,* and occasionally gambir, the mixture being used as a stimulant masticatory in India and the East Indies. In India the mixture is known as "punsupari." Betel chewing has been practiced since early times. The value of areca as a tænicide seems to have been known in the East for some time but was not known to western civilization until 1863.



seed showing rumination tissue (r) adjacent to the endosperm (en), the latter consisting of cells having thick, porous walls of reserve cellulose (Drawing by Wirth.)

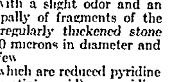
Description and Structure.—See Figure 53 and the National Formulary.

Powder—Weak reddish brown to light brown with a slight odor and an astringent, slightly bitter taste It consists principally of fragments of the endosperm *with porous, reserve-cellulose walls, irregularly thickened stone* cells of the seed coat, a few aleurone grains up to 40 microns in diameter and a few oil globules, starch absent and tracheal tubes few

Constituents—Areca contains several alkaloids which are reduced pyridine derivatives; among them guvacine (tetrahydro-nicotinic acid), arecaidine (tetrahydro-methylnicotinic acid), and arecoline (arecaidine methyl ester). Arecoline, 0 1 to 0 5 per cent, only, is of medicinal importance. It is a liquid ... rs as colorless ... A red phloba-

... section in a small drop ... p should be just large ... Cover with a cover-

glass and run a few drops of ...
the cover-glass Reddish br...



the edge of which crystallization in plates will be seen. Crystals are formed in the endosperm cells only, not in the cells of the rumination.

STANDARDS.—Areca contains not more than 2 per cent of adhering pericarp and not more than 1 per cent of other foreign organic matter, and yields not less than 0.35 per cent of ether-soluble alkaloids calculated as arecoline and not more than 2.5 per cent of total ash.

USES AND DOSE.—Areca finds its principal usage in veterinary practice, being employed as a vermicide and tænifuge. Average dose: dogs, 2 to 4 gm., sheep, 4 to 8 gm., based on the weight of the animal.

Arecoline Hydrobromide (N. F. 1936 to date) occurs as a white crystalline powder or in fine needle-like crystals having a melting-point of 170° to 175° C. It is odorless and has a bitter taste. Arecoline hydrobromide is soluble in water and alcohol, the aqueous solution being optically inactive.

TESTS AND STANDARDS.—Arecoline hydrobromide responds to the test for bromide, yields a red-brown precipitate with iodine and a yellow precipitate with bromine. When dried over sulfuric acid for twenty-four hours, it loses not more than 1 per cent in weight. It yields not more than 0.5 per cent of ash and should be free from other alkaloids and from sulfate.

USES AND DOSE.—Arecoline hydrobromide has been used in veterinary medicine for colic in horses. It is also a tænicide and a myotic. Average dose: horses, 30 mg subcutaneously; dogs, 1.5 mg. per kg. of body weight.

COCONUT

The **Coconut Palm** (*Cocos nucifera*) grows in the coast regions of all tropical countries and is most useful to the natives, furnishing food, clothing, utensils of all kinds, building materials, etc. It is a tall stately tree rising to the height of 100 feet, with a tuft of leaves at the top, and among which are borne fruits, often a hundred or more each year. The generic name *Cocos* is from the Greek, meaning "a berry" or "a pill", *nucifera* is from two Latin words, meaning "nut-bearing."

The following classification of the products obtained from the coconut palm shows its manifold uses.

Fruit
- Kernel (copra) for food and expression of fixed oil.
  - Coconut Oil for cooking, soap making, and pharmaceutical uses.
  - Coconut Oil Cake for cattle feed.
- "Milk" for a nourishing drink.
- Shell for native household articles.
- Husk (Coir) fiber for ropes, mats, carpets, brushes, etc.

Trunk
- Wood (Porcupine wood) for cabinet work, building and other construction, firewood, etc.

Leaves for thatching, plaiting, mats, baskets, etc.

Young Leaves for food.

Flower Spathe
- Juice for a sweet drink.
  - Fermented juice for a liquor (Toddy).
  - Distilled fermented juice for a strong liquor (Arrack).
  - Acid-fermented juice for vinegar.
  - Evaporated juice for palm sugar (Jaggery).

Coconut.—The coconut of commerce is the ripe fruit deprived of its husk (epicarp and mesocarp) thus consisting of the seed covered by the hard stony endocarp to which are attached a few fibers of the mesocarp. In the smaller end of the coconut occur usually three germinating "eyes."

Copra is the ripe kernels (meat) of the coconut, removed and dried in the sun. It yields up to 35 or 40 per cent of fixed oil. Sections of copra show more or less isodiametric cells containing needle-shaped fat crystals and large aleurone grains. Copra, sweetened and cut into shreds forms the **shredded coconut** used in cooking and pastry making.

Coconut Oil (N. F. 1946 to date) is the fixed oil obtained by expression or extraction from the seeds of *Cocos nucifera* Linné.

The fresh kernel contains 30 to 40 per cent of oil; copra yields about 65 per cent of oil. Copra expressed without heat yields first a thinner oil (**copra olein**), then a thicker oil (**copra stearin**). About 1.25 billion pounds of the oil are produced annually.

DESCRIPTION.—Coconut Oil is a pale yellow to colorless liquid at 28° to 30° C., at 20° C. it becomes semisolid, and at 15° C. it is hard, somewhat brittle and with a cl
but when w
insoluble in
petroleum b

CONSTITUENTS.—Trilaurin up to 50 per cent; trimyristin, up to 20 per cent; and other glycerides, including tripalmatin, tristearin, triolein, and tricaprylin, the free acid of the latter giving the oil an unpleasant odor. Chemically, it rather closely approximates butter.

USES.—It is extensively used in compounded edible fats, chocolate and candies; in hair dressings and other cosmetics, in soap, in candles and night lights, and pharmaceutically in ointment bases.

Coconut Shells.—The endocarp of the fruit, while used as a household article by the natives, is to some extent ground up and used extensively as an adulterant of powdered foods and drugs. The presence of coconut shells may be detected by their yellow stone cells, which have thick yellow walls with branching pores and dark brown contents. The stone cells vary from polygonal and isodiametric, to cylindrical and wedge-shaped forms that are quite characteristic. In addition there occur fragments of long thick-walled, porous fibers with accompanying stegmatic cells, each containing a spheroidal, tuberculated siliceous granule. The dark brown fragments in the powder are not affected by bleaching agents, such as Schulze's macerating solution.

Coir is the fibers of the mesocarp and is used in the manufacture of rope, brushes, coconut mats and coarse cloth.

OTHER PALM PRODUCTS

Palm Oil.—This is a fixed oil obtained from the fleshy part of the fruit of *Elæis guineensis*, a palm of western Africa, and cultivated in other tropical countries. The oil has the consistency of butter, a reddish yellow color, an agreeable odor a
the manufacture
to preserve it fr

Dragon's Blood, Sanguis Draconis or Resina Draconis. This is a resin prepared from the fruits of various species of *Calamus* (*Dæmonorops*), particularly *Calamus draco*. These are palms growing in Borneo and Sumatra. The product is a spontaneous exudation from the ripening fruit. It is separated from the fruit, softened with heat and molded into sticks and cakes, which are wrapped in strips of palm leaf. The term "dragon's blood" has been applied to products obtained from other plants, that mentioned by Dioscorides being from a liliaceous plant *Dracæna ombet* growing in Socotra.

Because of its stimulating and astringent properties, it was formerly used in

dentifrices, mouth washes, etc., but today it finds use mainly in the preparation of lacquers and varnishes (mahogany stain).

Date.—The date palm, *Phœnix dactylifera* is cultivated in northern Africa, southwestern Asia, Arizona and other tropical countries. It reaches a height of 60 feet, having a crown of pinnated leaves among which are several spadices each of which (on the female tree) bears from 180 to 200 fruits (dates). The trees are artificially pollinated to increase the crop. Dates contain about 47 per cent of invert sugar and are an important article of commerce. In northern Africa, Arabia and Persia they form the chief food and principal wealth of the people.

Sago (U. S. P. 1820 to 1882) consists of the starch prepared from the pith of the trunks of various palms and cycads growing in India and the East Indies, principally *Metroxylon rumphii* and *M. læve*. The pith is separated from the hard outer layers of the trunk, crushed, and the starch washed out on sieves. The characteristics of the starch have already been discussed (see page 120).

Carnauba Wax is obtained from the leaves of *Copernicia cerifera*, a palm ranging from northern Brazil to Argentina. The wax is considerably used in the manufacture of candles, wax varnishes, leather and furniture polishes, and other uses in place of beeswax.

Vegetable Ivory is the ripe subglobular seed, 3 to 5 cm in diameter, of various species of *Phytelephas*, nearly stemless palms found mostly in Colombia on the bank of the Magdelena River. These hard, white seeds are used for coat buttons and many other turned objects.

ARACEÆ, OR ARUM FAMILY

This family consists mainly of tropical plants characterized by an inflorescence consisting of a spadix placed within a spathe. There are about 900 species, most of them found in tropical and subtropical countries, only about 10 species growing in temperate regions. The latter are mostly perennial herbs possessing rhizomes or acrid corms. The inner morphology is not constant, some genera containing characteristic spicular cells; a few contain tannic acid; others contain oil cells as in calamus, and quite a number contain laticiferous cells. Some of the plants are highly ornamental and are extensively cultivated, as the caladiums.

CALAMUS

Calamus or Sweet Flag (U. S. P. 1820 to 1916; N. F. 1936 to date) is the peeled, dried rhizome of *Acorus calamus* Linné. The specific name *Calamus* means "a reed." The commercial supplies of the drug are obtained from [illegible] Indiana, North Carolina an[illegible] utumn, separated from le[illegible] times peeled before drying. During drying the rhizome shrinks considerably and loses about 75 per cent of its weight. Both peeled and unpeeled drug is found on the market but only the peeled is official, though unpeeled drug yielding not more than 2 per cent of acid-insoluble ash and meeting other conditions of the monograph may be used for extractive preparations. A confection is also made by "candying" the fresh rhizomes. The drug was employed in India in ancient times and was also known to the Greeks and Romans. The time of its introduction

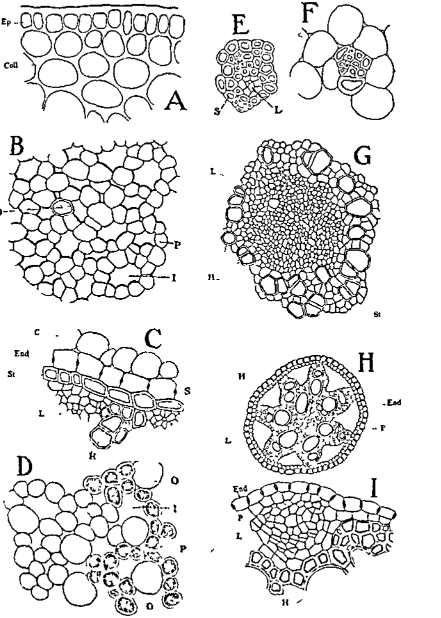


Fig 54 – *Acorus calamus* Figs. A to G from transverse section of the rhizome, H I

xylem strands at (*H*), and surrounded by the pericambium (*P*) and endodermis (*End*) I, from the same radial bundle but more highly magnified (After Holm)

into Europe is not known but it seems to have been used as early as the sixteenth century.

DESCRIPTION, STRUCTURE AND POWDER.—See Figure 54 and the National Formulary.

CONSTITUENTS.—Volatile oil 1.5 to 3.5 per cent; acorin, a bitter, viscid aromatic glycosidal principle, which when hydrolyzed in a current of hydrogen yields oil of calamus; choline (trimethyl-hydroxy ethyl ammonium hydroxide), a strong, non-poisonous base, formerly known as calamine; a soft resin about 2.3 per cent; tannin; mucilage; starch and calcium oxalate. Total ash about 4.35 per cent; acid-insoluble ash about 0.15 per cent.

STANDARDS AND TESTS.—Calamus yields not less than 1.2 cc. of volatile oil of calamus from each 100 gm. of drug. It contains not more than 1 per cent of foreign organic matter, not more than 6 per cent of total ash and not more than 0.5 per cent of acid-insoluble ash. Powdered calamus contains no starch grains over 10 microns in size (cereal flours and althea).

USES AND DOSE.—Calamus is a carminative, a stimulant and an aromatic bitter tonic and is used as a flavoring agent. Average dose, 3 gm.

Arum, Indian Turnip or Jack-in-the-Pulpit (U. S. P. 1820 to 1873) is the corm of *Arisæma triphyllum*, a common plant growing in rich woods in eastern North America The corms are gathered, cut transversely into pieces and dried It contains a volatile acrid principle, probably an alkaloid, mucilage; and calcium oxalate in long raphides. Arum is used as a stimulant, expectorant, irritant and diaphoretic.

European Arum, or Tubera Ari is the corm of *Arum maculatum*, a perennial herb growing in central and southern Europe The corms are gathered in the spring, sliced transversely and dried. The constituents and properties are similar to those of Indian turnip.

Dracontium or Skunk Cabbage (U. S. P. 1820 to 1882) is the dried rhizome and roots of *Symplocarpus fœtidus*, an herb indigenous to moist ground in North America. It contains volatile oil, resin and an acrid principle and is used to some extent as an antispasmodic, emetic and diuretic.

Tonga is a mixture of equal parts of the root of *Epipremnum pinnatum* (Fam. *Araceæ*) and the bark of *Premna arborea* (Fam. *Verbenaceæ*) and is described on page 522

LILACEÆ, OR LILY FAMILY

These are mostly perennial herbs having bulbs or tubers and rarely fibrous roots. There are about 200 genera and 2600 species and they are found in nearly all portions of the globe. A few are used in medicine, some furnish
uses. The le
are regular and with 6 stamens, and a superior (rarely inferior) trilocular ovary. There are no striking anatomical characteristics; the fibrovascular bundles are concentric and arranged in several rows, outside of which and within the endodermis is a ring of sclerenchymatous fibers. The underground organs usually contain starch and not infrequently mucilage cells enclosing raphides.

VERATRUM VIRIDE

Veratrum Viride, American or Green Hellebore (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the dried rhizome and roots of *Veratrum viride* Aiton.

Veratrum is from the Latin *vere* meaning truly, and *ater* meaning black; *viride* is Latin, meaning green. The plant is found growing in wet meadows in the mountainous sections of New England and the eastern United States, south to North Carolina, Tennessee and northern Georgia. Most of the commercial drug is collected in New York State south to the Pennsylvania line. The rhizomes are dug, cleaned, cut longitudinally and dried. The drug was known to the Indians who probably introduced its use to the early settlers.

FIG. 55.—Plants of *Veratrum viride* growing in the Royal Botanic Society's Gardens (London) and showing the parallel-veined (or nerved) leaves with entire margin and the large terminal panicles of flowers. (After Perrédes.)

European or White Hellebore (U. S. P. 1820 to 1882) is the rhizome of *Veratrum album*, a plant similar to *Veratrum viride*, but indigenous to central and southern Europe. Much of the green hellebore used in America is obtained from *Veratrum album* and imported from Germany.

DESCRIPTION AND HISTOLOGY. See Figure 56 and the National Formulary. White hellebore is similar in appearance and structure to green hellebore, but the external color is much lighter.

POWDER. Grayish brown to dark brown, strongly sternutatory, taste bitter and acrid (see Fig. 56).

CONSTITUENTS.—Four alkaloids have been isolated from both varieties: (1) *protoveratrine* (about 0.03 per cent); (2) jervine (about 0.13 per cent);

tion.

STANDARDS.—Veratrum Viride contains not more than 5 per cent of its stems or other foreign organic matter and yields not more than 4 per cent of acid-insoluble ash. A bioassay using **Daphnia** as the test animal is used in standardizing preparations of Veratrum Viride.

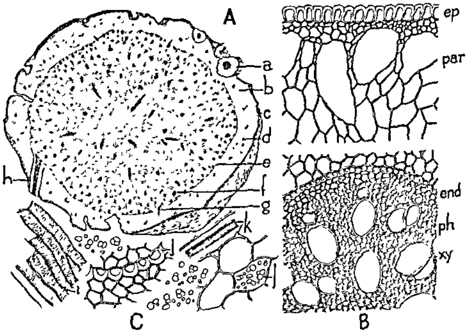


FIG. 56.—*Veratrum viride.* *A*, transverse section of the rhizome· *a*, section of a root near its origin in the rhizome, *b*, the cortex with an outer layer (*c*) of brownish cork-like cells, numerous fibrovascular bundles (*d*) often cut obliquely, and parenchyma containing raphides of calcium oxalate and starch; (*e*) endodermal layer occasionally broken by leaf-trace bundles (*g*) or root bundles (*h*), *f*, vascular bundles of the central cylinder in interrupted circles, or scattered throughout the central parenchyma *B*, some tissues from the transverse section of the root *ep*, epidermal cells with lignified thickened outer and radial walls, *par*, parenchyma similar to that of the rhizome, but interspersed with large irregular cavities in the outer regions of the root cortex; *end*, endodermal cells with inner and radial walls thickened and lignified. The central fibrovascular radial bundle contains from 6 to 15 xylem (*xy*) rays and as many alternating phloem (*ph*) strands

bein
freq
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(Drawing by Florence Carpenter.)

USES AND DOSE.—Veratrum Viride is a cardiac depressant and a sedative; it slows the heart and lowers blood pressure and it has shown considerable value in Average dose, 100 mg. The powdered hellebore rdeners may consist of either white or green he rmer.

ADULTERANTS.—Sand and dirt to the extent of 25 per cent or more may be present in white hellebore.

The rhizome of *Veratrum viridifolium*, a plant with greenish flowers growing in the mountainous districts of Europe and northern Asia, contains jervine and veratroidine. The rhizome of *Veratrum nigrum*, a plant with purplish red flowers, indigenous to middle and eastern Europe, Siberia, Manchuria and Japan, contains jervine. *Veratrum californicum*, of the western United States, is very similar to *V. album*, possibly a transitional form between *V. album* and *V. viride*.

Sabadilla (U. S. P. 1842 to 1882) is the seed of *Schœnocaulon officinalis*, a bulbous plant indigenous to Mexico and the West Indies The seeds are brownish black, 5 to 8 mm. long, narrow, angular, beaked, with a bitter and acrid taste. They contain about 1 per cent of a mixture of alkaloids.

Veratrine (U. S. P. 1842 to 1916; N F. 1926 to 1936) is a mixture of alkaloids obtained from the seed of *Schœnocaulon officinalis* The drug consists of cebadine, cevadilline, sabadine and sabadinine. A decoction of sabadilla seed or ointment prepared from veratrine is used to destroy body lice.

Black Hellebore has sometimes been sold under the name of American Hellebore. [illegible] veratrum viride [illegible] herapeutic effect. [illegible] its knotty appear [illegible]

COLCHICUM

Colchicum Corm (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried corm of *Colchicum autumnale* Linné.

Colchicum Seed (U. S. P. 1831 to 1946; N. F. 1946 to date) is the dried ripe seed of *Colchicum autumnale* Linné.

Colchicine (U. S. P. 1905 to date) is an alkaloid obtained from *Colchicum autumnale* Linné.

The genus name is from Colchis on the Black Sea, where the plant flourishes; *autumnale* refers to the season when the plant blooms The plant is cultivated in England, central and southern Europe and northern Africa, growing in moist meadows. It is now cultivated also in Washington, Oregon and northern California Two to six flowers having long perianth tubes develop from the corm buds in the fall, the fertilized ovary remaining underground during the winter, and developing the fruit above ground along with the leaves the following spring and summer. The seed is collected in July and August and the corm in the spring before leaf development.

Dioscorides mentions a *Colchicum*. The Arabs recommended the use of the corm for gout in medieval times. It came into usage in Europe about the middle of the seventeenth century and the seed about 1820.

[illegible] —See Figures 57 and 58 and the [illegible]

[illegible] up to 0.8 per cent in the seed and 0.6 per cent in the corm The seeds also contain fixed oil (about 6 per cent), proteins; colchicoresin; starch grains in the caruncle, and about 2.5 per cent of total ash. The corm contains much starch and two resins

STANDARDS.—Colchicum Seed yields not less than 0.45 per cent of colchicine, and not more than 1 per cent of acid-insoluble ash. Colchicum Corm yields

not less than 0.25 per cent of colchicine and not more than 0.5 per cent of acid-insoluble ash.

USES AND DOSE.—Colchicum is an alterative, a sedative and a diuretic. It is used chiefly as an antirheumatic in gout and rheumatism. Average dose of the seed 200 mg.; of the corm 250 mg.

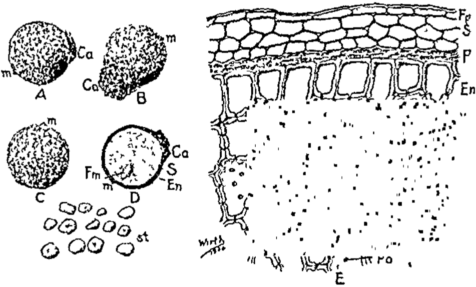


FIG 57.—Colchicum Seed. A, B and C, ovoid to irregularly globular seeds (2 to 3 mm. in diameter), minutely pointed at the micropyle (m) and with a distinct beak or caruncle (Ca) which is sometimes absent (C) The seeds are dark brown externally, finely pitted, very hard, inodorous, bitter and acr ... (D) they show a dark brown seed coat (S) and a whitish o ... which is a small embryo (Fm) usually from ... ransverse section of the seed (E) shows a seed coat (S) usually consisting of ... cells, the ... (except the outer row of cells which exhibit pores only on their inner walls). The ...

Colchicine is prepared by exhausting the seed (or corm) with hot alcohol, evaporating the alcohol, taking up in water and shaking out the aqueous solution with chloroform. The chloroform solution yields chloroform-colchicine (see below) upon evaporation; it is then taken up in alcohol, heated to remove the chloroform and finally taken up in ether from which the alkaloid is separated. Colchicine has one aliphatic nitrogen atom.

DESCR ... or in powder which gr ... oluble in 22 cc of ... n alcohol and chloroform.

TESTS —There are no known satisfactory microcrystalline reactions for ... ntrated sulfuric ... nitrate) ... violet to

IMPUR ... is formed from colchicine as the resul ... id media, but may ... th methyl alcohol. ... ic chloride

solution are added to 5 cc. of a 1 per cent aqueous solution of colchicine, no color is produced in the mixture (*colchiceine*) but upon heating, the mixture develops a brownish red changing to brownish black

2. **Chloroform-colch**

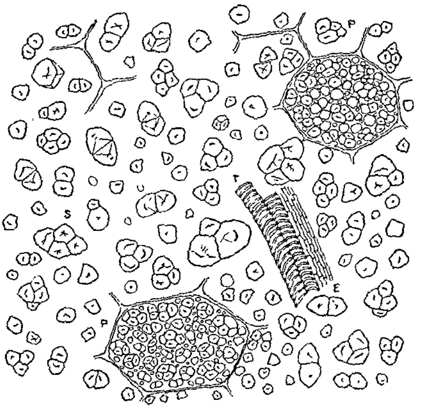


FIG. 58 —Powdered *Colchicum Corm* Light brown or grayish brown fragments of thin-walled parenchyma (*P*) containing starch, starch grains (*S*) numerous, single or

panied by sieve (*E*), occasional fragments of walls.

USES AND DOSE —Colchicine is used for the same purposes as colchicum corm and seed In combination with methyl salicylate, colchicine is believed to be superior to the crude drug for the treatment of gout Dose, 0 5 mg. *Colchicine is extremely poisonous*

The use of colchicine as a means of doubling chromosomes has opened a large field in plant genetics Any numerical change in chromosome number entails a mutation which becomes evident in a number of the characteristics

dispersal of tumors

Erythronium or Yellow Adder's Tongue (U. S P. 1820 to 1863) consists of the root and herb of *Erythronium americanum* and is used like colchicum In large doses it is emetic.

ALOE

Barbadoes or Curacao Aloe	*U. S. P.*
Aloe vulgaris Lamarck	1820 to 1882
Aloe vera Linné	1894 to date
Aloe chinensis Baker	1905 to 1916
Aloe barbadensis Miller	1942 to date
Cape Aloe	
Aloe spicata Baker	1851 to 1882, 1942 to date
Aloe ferox Lamarck	1916 to 1936, 1942 to date
Aloe africana Miller	1942 to date
Socotrine Aloe	
Aloe spicata Linné	1820 to 1851
Aloe socotrina Lamarck	1851 to 1894
Aloe Perryi Baker	1894 to date

Aloe, or Aloes (U. S. P. 1820 to date) is the dried juice of the leaves of *Aloe Perryi* Baker, known in commerce as Socotrine Aloe; or of *Aloe barbadensis* Miller (*Aloe vera* Linné), known in commerce as Curaçao Aloe; or of *Aloe ferox* Miller and hybrids of this species with *Aloe africana* Miller and *Aloe spicata* Baker, known in commerce as Cape Aloe.

Aloe is from the Arabic word *alloeh* or the Hebrew *halal*, meaning a shining, bitter substance; *vera* is from the Latin *verus*, meaning true, and *Perryi* is in honor of Wykeham Perry who made extensive studies on the plant. *Barbadensis* refers to the Barbadoes Islands; *ferox* is from the Latin meaning wild or ferocious; *africana* refers to the habitat of the plant, southern Africa; and *spicata* refers to the flowers in spikes

There are about 150 species of *Aloe* known, most of which are indigenous to Africa. Many have been introduced into the West Indies and Europe. The aloes are typical xerophytic plants with fleshy leaves, usually having spines at the margin, and resemble to some extent the agave or century plant (*Agave americana*, Fam. *Amaryllidaceæ*).

Aloe Perryi grows on the Island of Socotra, in East Africa, and in Arabia The plant is a perennial herb having a stem about 25 cm. long and 5 cm. in diameter surmounted by a rosette of about 20 leaves from 30 to 40 cm. long and from 5 ... and the juice from the cu ... spontaneously. ... cotra, and along t ... where it is further dried and from where it is exported in kegs or tins. It is said that Socotrine aloe was known to the Greeks as early as the fourth century B C. Alexander the Great sent a commission to the Island of Socotra to investigate the cultivation of the drug in 333 B C It was probably introduced into western Europe about the tenth century by the Arabs.

Aloe vera has a stem about 50 cm. high, the leaves being up to 50 cm. long, flat on one surface and convex on the other and having the spines arranged perpendicularly on the margin It is a native of northern Africa but was introduced into the Barbadoes Islands in the seventeenth century. *A. chinensis*, a variety of *A. vera*, was introduced into Curaçao from China in 1817. The drug was cultivated to a considerable extent in Barbadoes until the middle of the

nineteenth century, but since that time the industry seems to have died out. Curaçao aloe which is still often called Barbadoes aloe comes from the Dutch *Islands of Curaçao*, Aruba and Bonaire. The leaves are cut in March and April and placed cut-end downward in a V-shaped *trough, the latter being inclined* so that the juice may be led into a vessel The juice is evaporated in a copper kettle and when of the proper consistency is poured into boxes or gourds and allowed to harden.

FIG 59.—*Aloe vera*, the plant yielding Barbadoes aloe Showing crown of thick succulent leaves and the long spike (inflorescence) with the flowers on the upper portion of the axis (After Engler)

Cape Aloe is exported from Cape Colony and is largely used in veterinary practice.

DESCRIPTION AND POWDER. See the U. S Pharmacopœia When powdered aloe is mounted in water the fragments tend to dissolve, leaving, however, a granular, insoluble residue Glycerin mounts of Socotrine aloe show minute crystals of aloin embedded in the fragments

CONSTITUENTS.—Aloe contains aloin (barbaloin), 5 to 30 per cent; a pale yellow volatile oil; resinous material 16 to 63 per cent; ash 1 to 4 per cent; moisture 10 to 20 per cent.

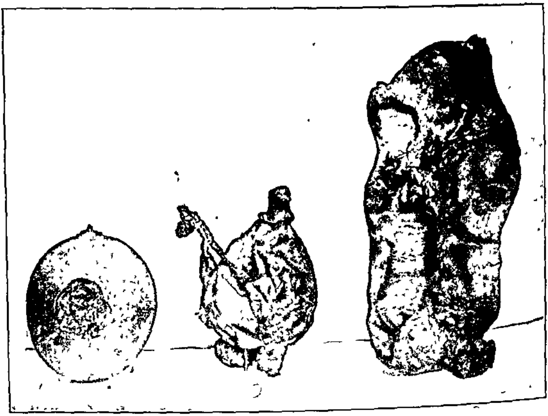


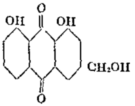
FIG 60 —Special containers used in the shipment of aloes. The one on the left is a gourd and is still commonly used; the other two are sewed-up monkey skins which are now only occasionally seen in the market.

Aloin (U. S. P. 1894 to date; as a reagent, U. S. P. 1916 to 1926; N. F. 1926 to 1936) is a mixture of active principles obtained from aloe. It varies in chemical composition and in physical and chemical properties according to the variety of aloe from which it is obtained. Curaçao aloe yields the highest percentage of aloin (barbaloin) and it is the usual commercial aloin.

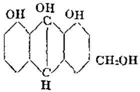
PREPARATION.—Dissolve aloe in 10 parts of boiling water; acidulate with sulfuric acid; cool to precipitate resin; filter and evaporate *in vacuo* to about 2 parts; seed with a crystal of aloin and allow to crystallize; wash the separated crystals with water and recrystallize from dilute alcohol. The yield varies from 4 to 30 per cent, from the different kinds of aloe.

PROPERTIES —Aloin is a lemon-yellow to dark yellow microcrystalline powder, with a slight odor of aloe and an intensely bitter taste. It is readily soluble in water (not more than 1.5 per cent of insoluble residue in cold water); and easily decomposed in acid, and especially so in alkaline solutions. It yields not more than 0 6 per cent of ash

Barbaloin is an anthraquinone glycoside and yields upon hydrolysis, *d*-arabinose, aloe-emodin and a reduction product, the anthranol of aloe-emodin (see Anthraquinone Derivatives, page 312).



Aloe emodin



Aloe emodinanthranol

Curaçao aloe contains a characteristic, crystalline isobarbaloin, Cape aloe an amorphous *b*-barbaloin, also present to some extent in Socotrine aloe, but is said to be absent from Curaçao Aloe contains enough free anthraquinones to give the Borntrager test. The aloe resins consist of resinotannols combined with cinnamic or *p*-hydroxycinnamic (*p*-coumaric) acids

STANDARDS —Aloe yields not more than 4 per cent of ash, not more than 12 per cent of moisture, and not less than 50 per cent of water-soluble extractive.

TESTS.—Prepare a solution by macerating 1 gm of powdered aloe in 100 cc of water for two hours with frequent agitation, filter and use the filtrate for the following tests.

1. **Schönteten's Reaction.**—Mix 5 cc of the filtrate with 45 cc. of water and add 20 cc of a solution of sodium borate (1 in 20) to the mixture A green-

anthranol. All varieties of aloe give the reaction

2. **Bornträger's Test.**—Dilute 10 cc of the filtrate to 100 cc with water and shake the dilution with 10 cc of benzene Separate the benzene layer and shake it with 5 cc. of ammonia T.S a deep rose color is produced in the lower layer This test is commonly applied to all anthraquinone drugs (see page 348) and is due, in this case to aloe-emodin which is present to some extent in the free state in al

3. **Colo** ... te flask the filtrate from Socotrine ... orange, and from Cape aloe greenish yellow

4. **Nitric Acid Reactions.**—Add 2 cc of nitric acid to 5 cc of the filtrate Socotrine aloe gives a yellow col ... Cape aloe a reddish brown color changing ... be applied directly to the powdered drugs

5. **Cupraloin Test.**—Mix 5 cc of the filtrate with 5 cc of water, add a drop of 10 per cent copper sulfate solution, about 0 5 gm of sodium chloride and 1 cc of alcohol and warm gently. With Curaçao aloe the color changes to reddish violet and remains permanent The test is a specific one for isobarbaloin and therefore is an identity test for Curaçao aloe Socotrine aloe gives no reddish violet color and Cape aloe gives a transient pink (Cape aloe contains traces of isobarbaloin)

6. **Nitrous Acid Test.**—Add a few crystals of sodium nitrite to 5 cc. of the filtrate and follow with a drop of glacial acetic acid and shake In the presence ... red With ... This test ... aining it. ... e intestine ... n , of aloin, 15 mg.

ADULTERANTS —Aloe has been found adulterated with gums, dirt and various mechanical impurities and with drugs from which the aloin has been removed. One commercial variety is frequently substituted for another more expensive one. The absence of gum or inorganic impurities is indicated by a nearly clear solution after gentle heating and then cooling a 2 per cent solution of aloe in alcohol.

Allied Products.—Several other commercial varieties of aloe are found on the market among which the following might be named:

Zanzibar Aloe is probably a "hepatic" variety of Socotrine aloe. It is usually

evaporation of the juice which permits minute crystallization in the mass. "Vitreous" or "glassy" aloes, made by rapid evaporation, show no imbedded crystals, hence in thin layers are translucent, bright and shiny.

Uganda Aloe is the hepatic variety of Cape aloe.

Natal Aloe is a hepatic variety of aloe which was at one time exported from Natal, the botanical origin being unknown. It resembles Cape aloe, but the powder dissolved in nitric acid assumes a permanent crimson color; dissolved

tric acid produces a deep blue color; these tests es of aloe. It contains nataloin but not emodin. n other aloes.

variety obtained from the East Indies and is ex [illegible] which is apparently ch

y *Aloe barbadensis*, have been used to increase the rate of healing of acute *X*-ray burns

SQUILL

Squill, Scilla bulbus P. I. (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the cut and dried fleshy inner scale of the bulb of the white variety of *Urginea maritima* (Linné) Baker, known in commerce as White or Mediterranean Squill; or of *Urginea indica* Kunth, known in commerce as Indian Squill.

Scilla is from the Greek *skilla*, meaning to split (referring to the separating scales); *Urginea* may be from the Latin *urgere*, meaning to press and referring to the compressed seed, *maritima* is from the Latin and refers to the habitat of the plant on the Mediterranean coasts of Spain, France, Italy, Greece, Algiers and Morocco The bulbs, which grow half immersed in the sandy soil near the sea, are gathered late in August and after removal of the membranous outer scales and the central portion, the fleshy scales are cut into transverse pieces and dried. Squill was known to the Egyptians and to the Greeks. Dioscorides mentions a vinegar of squills, and an oxymel of squill was used by Arabian physicians.

Description and Histology.—See Figure 61 and the National Formulary.

Powder.—Yellowish white to very pale brown, with a slight odor and a mucilaginous, bitter and acrid taste. It has a tendency to form a hard cake unless kept in a dry atmosphere. The characteristic crystals of calcium oxalate are the longest in any drug and alone serve to identify it, the spiral or reticulate tracheæ are few, starch grains are rare, and only occasional stomata are found.

Constituents.—Scillaren-A is crystalline, sparingly soluble and comprises about two-thirds of the total glycosidal content. Upon hydrolysis it yields

man's reagent, an [illegible]-like reaction

STANDARDS.—Squill, as fluidextract, possesses a potency per cubic centimeter equivalent to not less than 0.8 mg. and not more than 0.9 mg. of standard ouabain.

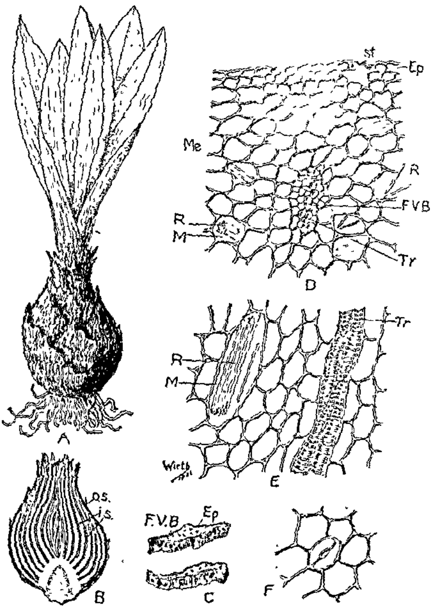


FIG. 61.—*Urginea maritima.* *A*, entire plant in the leaf stage showing bulb with outer coriaceous scales. *B* ... inner scales (is). C, ... in irregularly curved ... orange or pale yellow ... (*FVB*). The drug h... transverse section of the outer portion of a scale showing thin-walled epidermis (*Ep*) with occasional stomata (*st*); mesophyll (*Me*) composed of parenchyma, an occasional vascular bundle (*FVB*) with spiral tracheæ (*Tr*), and frequent longitudinally elongated cells containing mucilage (*M*), embedded in which are bundles of calcium oxalate raphides (*R*) up to 1000 microns in length. *E*, longitudinal section through a scale. *F*, surface view of the epidermis showing a stoma. (Drawing by Wirth.)

USES AND DOSE.—Squill is an expectorant, an emetic, a cardiac stimulant and a diuretic. Average dose, 100 mg. Scillaren, a mixture of the glycosides of squill in natural proportions, and Scillaren-B possess a cardiac action similar to that of digitalis, though the action may not be as persistent. The oral dose of scillaren is 1.6 mg. three to four times daily; the intravenous dose of scillaren-B is not more than 0.5 mg. during twenty-four hours.

ADULTERANTS AND SUBSTITUTES.—Squill has been adulterated with stones resembling the drug in size and color. The bulbs of several species of *Crinum* (Fam. *Amaryllidaceæ*) found growing in Brazil, China, southern Asia and the East Indies have been used as substitutes for squill.

Red Squill consists of the bulb or bulb scales of the red variety of *Urginea maritima*, which is imported to a considerable extent for use as a rat poison. It should not be present in the official squill and may be detected by the presence of red, pink or purple epidermal or parenchyma tissues.

Allium or Garlic (U. S. P. 1820 to 1905; N. F. 1916 to 1936) is the fresh bulb of *Allium sativum* Linné. It is a native of southern Europe and is extensively cultivated, being considerably employed as a condiment. The bulb is subglobular, 4 to 6 cm. broad, compound, consisting of 8 to 15 bulbels and surrounded by 1 or 2 dry, whitish, membranous scales and attached to a flattened circular base, from the lower portion of which arise numerous yellowish white roots, odor aromatic, disagreeable; taste intensely pungent and persistent.

Garlic contains about 0.25 per cent of a yellowish volatile oil containing sulfur compounds and having a strong unpleasant odor. It is a carminative, an expectorant and a diuretic, the average dose being 2 gm.

CONVALLARIA

Convallaria Root or Lily-of-the-valley Root (U. S. P. 1882 to 1916; N. F. 1916 to date) consists of the dried rhizome and roots of *Convallaria majalis* Linné.

Convallaria Flowers or Lily-of-the-valley Flowers (N. F. 1916 to 1926) is the dried inflorescence of *Convallaria majalis* Linné, without the presence of more than 5 per cent of foreign matter.

Convallaria is from the Latin *convallis*, meaning growing in valleys, and *leiron*, meaning lily; *majalis* signifies blooming in May. The plant is a low-growing perennial herb indigenous to Europe, Asia and the mountains of southeastern United States, and is extensively cultivated for its flowers.

The flower is collected in the spring and the rhizome and roots in late summer. Both are carefully and promptly dried. Convallaria has been used as a domestic remedy for centuries, and entered into general medical practice about 1850. It has never attained the reputation of digitalis. The relative potency between Convallaria herb, flowers and rhizome-roots is the ratio 6:10:85.

DESCRIPTION, HISTOLOGY AND POWDER.—Of Convallaria Root, see Figure 62 and the National Formulary. The flower drug consists of racemes of white flowers (brownish when dried) on long greenish flower stalks; the perianth is bell-shaped, 6-parted, recurved; stamens 6, and ovary 3-locular. The odor is fragrant and the taste sweet and acrid.

CONSTITUENTS.—In Convallaria Root: convallamarin, a bitter, crystalline glycoside, about 0.6 per cent, which is soluble in water, alcohol and ether and has a physiological action similar to digitalin, an acrid glycoside, convallarin, insoluble in ether and sparingly soluble in water, the solution foaming like that

of a saponin; and convallatoxin, occurring in needle-like crystals only slightly soluble in water. The flower drug probably contains the active constituents mentioned above as well as a volatile crystalline principle which is very fragrant

STANDARDS.—Convallaria Root, when tested by the official method, possesses

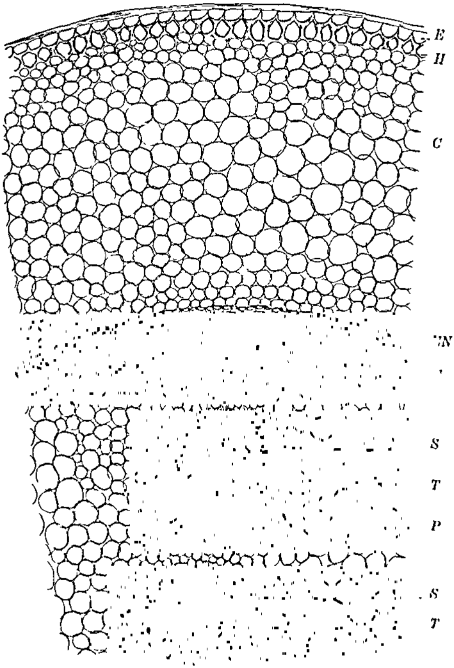


FIG. 62. Convallaria Rhizome. *E*, epidermis bearing a thick layer of cutin. *H*, hypodermis of collenchyma. *C*, cortex of about 20 rows of parenchyma, bearing starch and calcium oxalate. *EN*, endodermis with cells which have the radial and inner walls thickened and adjacent to which lie U-shaped closed collateral bundles. *S*, sieve. *T*, tracheæ and fibers. *P*, parenchyma.

a potency such that 0.1 gm. of it is equivalent to 3 U. S. P. digitalis units. It contains not more than 5 per cent of leaves or other foreign organic matter and yields not more than 6 per cent of acid-insoluble ash.

USES AND DOSE.—Convallaria is a heart tonic and a diuretic. Average dose of Convallaria Root 30 mg.; of the flower drug 500 mg.

al, the rhizome and roots of *Polygonatum* , asparagin, mucilage and starch.

SARSAPARILLA

Honduras	*U. S. P.*
Smilax Sarsaparilla	1820 to 1842
Smilax officinalis Kunth	1842 to 1942
Smilax Regelii Killip and Morton	1942 to date
Mexican	
Smilax medica Chamisso and Schlechtendal	1882 to 1942
Smilax aristolochiæfolia Miller	1942 to date
Para	
Smilax papyracea Duhamel	1894 to 1916
Jamaica	
Smilax ornata Hooker	1905 to 1942
Ecuadorian	
Associated with Honduras	1942 to 1947
Undetermined species of Smilax	1947 to date
Central American	
Associated with Jamaica	1926 to 1942
Undetermined species of Smilax	1942 to date

Sarsaparilla (U. S. P. 1820 to date) is the dried root of *Smilax aristolochiæfolia* Miller, known in commerce as Mexican Sarsaparilla; or of *Smilax Regelii* Killip and Morton, known in commerce as Honduras Sarsaparilla; or of undetermined species of *Smilax* respectively known in commerce as Ecuadorian and Central American Sarsaparilla.

The name Sarsaparilla is from the Spanish *zarza*, a bramble, *parra*, a vine, and *illa*, small—a small brambly vine. *Smilax* is the Greek name for the yew and several other plants; *officinalis* means a workshop and alludes to the use of the root in the drug shop; *medica* refers to the medicinal qualities; and *ornata* to the ornamental character of the species; *aristolochiæfolia* refers to the leaves similar to those of several aristolochia species; and *Regelii* is in reference to the botanist Dr. Edward Regel, who has done much work on these *Smilax* species.

The plants are climbing or trailing vines with prickly stems, usually growing in damp soil. The roots are dug (sometimes with the rhizome) and dried in the sun. The rhizomes are short, thick and knotty; the roots are very long, roughly furrowed and quite uniform in thickness, seldom exceeding 6 mm. in diameter. The masses of roots are loosely bundled or tightly rolled and bound into cylinders according to the commercial kinds.

DESCRIPTION, HISTOLOGY AND POWDER.—See Figures 65, 66, 67 and the U. S. Pharmacopœia.

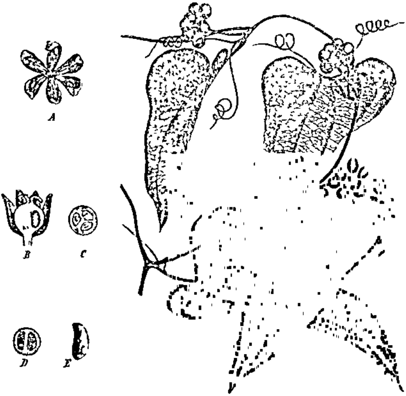


FIG 63 —*Smilax aristolochiæfolia* yielding Mexican sarsaparilla To the right a portion

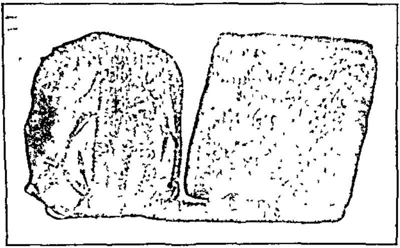


FIG 64 —"Ceroons" made of hide, in which Honduras sarsaparilla is imported

CONSTITUENTS.—Power and Salway succeeded in isolating *sitosterol-d-glycoside (phytosterolin)*, *sitosterol*, *stigmasterol*, a new crystalline sarsapic acid and a crystalline glycoside, *sarsasaponin*. Parillin and smilacin, which have been reported as glycosides, have been shown, by them, to be impure forms of

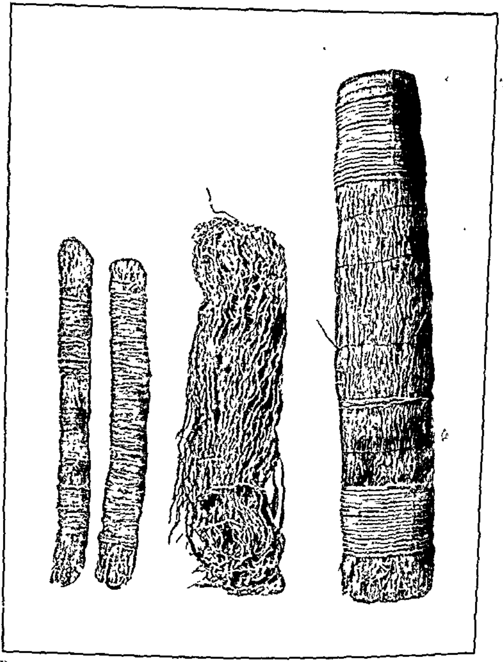
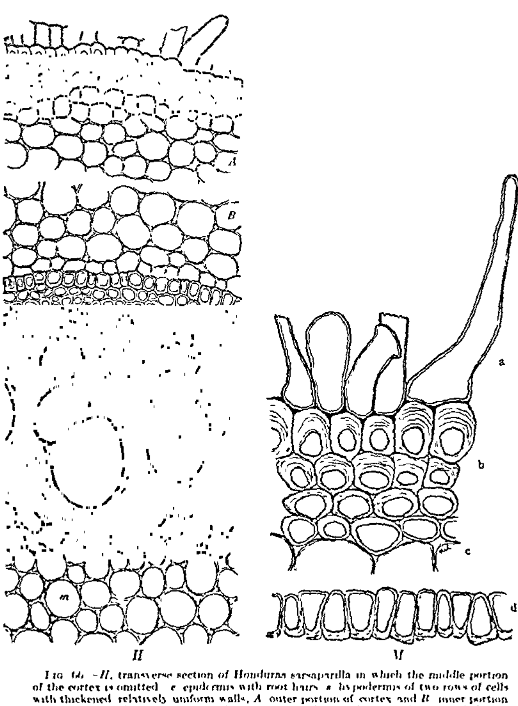


FIG. 65 - Bundles of sarsaparilla, the two on the left being Honduras, the next one, Mexican, and the large one, Para, which is, however, not an article of commerce at the present time (About ½ natural size)

sarsasaponin. Sarsaparilla also contains considerable starch and calcium oxalate.

STANDARDS.—Sarsaparilla contains not more than 2 per cent of foreign organic matter, other than the rhizome and crown portion. Mexican and Ecuadorian sarsaparilla contain not more than 10 per cent of rhizome and



H *M*

Fig. [illegible].—*H*, transverse section of Honduras sarsaparilla in which the middle portion of the cortex is omitted: *e*, epidermis with root hairs; *s*, hypodermis of two rows of cells with thickened relatively uniform walls; *A*, outer portion of cortex and *B*, inner portion of cortex, with cells containing starch, resin or raphides of calcium oxalate; *k*, endodermis of nearly square cells with uniformly thickened walls; *g*, tracheæ; *h*, sieve cells; *m*, parenchyma of the pith, the cells resembling those of the cortex. The thick-walled cells around the tracheæ (*g*) and phloem (*h*) are sclerenchyma fibers. (After Laurssen.) *M*, Mexican sarsaparilla in transverse section: epidermis (*a*) of radially elongated cells (root-hairs); hypodermis (*b*) of three or more rows of cells with the outer walls more thickened than the inner; parenchyma cells (*c*) and endodermis (*d*) of radially elongated cells with the inner walls more thickened than the outer. The walls of hypodermal and endodermal cells are slightly lignified, dry with an outer lamella of suberin. (Drawing by M. C. Day.)

stem, and Mexican sarsaparilla yields not more than 4 per cent of acid-insoluble ash. The other official sarsaparillas yield not more than 2 per cent of acid-insoluble ash.

USES AND DOSE.—Sarsaparilla is a tonic and an alterative. Average dose, 2 gm.

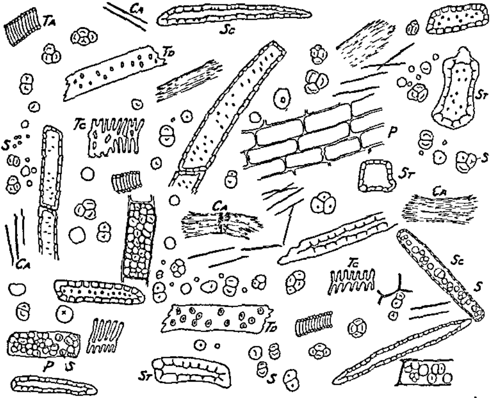


FIG. 67.—Powdered Sarsaparilla: consisting mostly of starch-bearing parenchyma ... in diameter, spheroidal, ... frequently with a ... th of 150 microns, occurring singly or in groups, cells of the hypodermis and endodermis with lemon-yellow or reddish yellow porous wa... or irregular thickening, th... tracheæ with simple and b... thickenings, and associated lignified and porous walls, (Drawing by Hogstad.)

Aralia Nudicalis, Aralia Racemosa and Aralia Spinosa (see pages 456 to 458) have been used medicinally as alteratives and tonics. Aralia Nudicalis is commonly ... The roots of *Cocculus villosus* are use...

Chin... It consists of the tuberous roots o... **...ndian Sarsaparilla** is derived ... *...cæ*). **Para Sarsaparilla** (U. S. P. ... formerly imported from *South* ... market (see Fig. 65).

... P. 1820 to 1873; N. F. 1916 to 1947) consists of the dried rhizome and roots of *Aletris farinosa* Linné. The plant is a perennial herb with spreading lanceolate leaves crowded at the base and a long slender scape terminated by a raceme of small, white, tubular flowers. It is common in the pine barrens and grows in grassy woods throughout the

eastern United States. Commercial supplies come largely from North Carolina, Virginia and Tennessee.

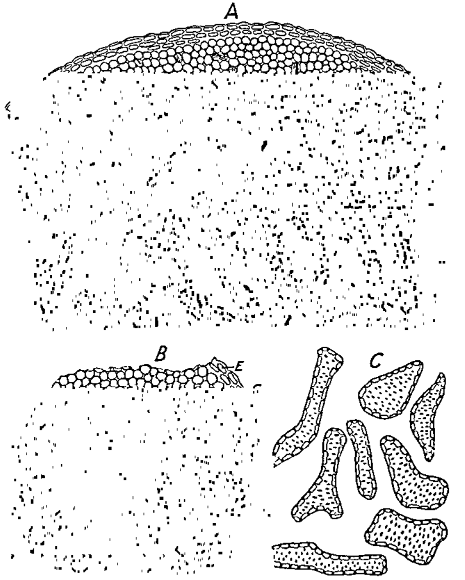


FIG. 68.—*Aletris*. *A*, transverse section of rhizome showing epidermis (*E*), cortical parenchyma containing either starch grains (*S*) from 2 to 10 microns in diameter or raphides of calcium oxalate (*Ca*) from 15 to 35 microns in length, endodermis (*En*) more or less distinct in the living plant but usually not well marked in the drug, fibrovascular bundles composed of tracheæ (*T*) and sieve (*L*), sclerenchymatous fibers (*Sc*). *B*, transverse section of root showing epidermis (*E*); cortical parenchyma containing starch (*S*), endodermis (*En*) consisting of thick-walled reddish fibers, tracheæ (*T*), sclerenchymatous fibers (*Sc*), sieve (*L*). *C*, isolated, porous sclerenchymatous cells from the rhizome. (Drawn by Hasse.)

Rhizome horizontal or slightly oblique, somewhat contorted, from 2 to 4 cm in length, 5 to 12 mm. in [illegible] with circular stem scars an[illegible] with numerous pale yellow [illegible]

exposing the reddish brown endodermal layer of the stele and giving them a wir ... nally light brown; odor slight, acetous; tas

... 68. ... a bitter principle and is used as a uterine tonic and a diureti ...

Helonias, Blazing Star or False Unicorn ... the dried rhizome and roots of *Chamælirium luteum* (Linné) Asa Gray. The plant is a perennial, dioecious herb having a rather fleshy bitter rhizome, a number ... n 3 to 5 dm. in length ter- ... It grows in moist meadows

... ndrical, from 0.5 to 3 cm. ... s of bud-scales; *upper portion* with numerous whitish ... rom the cortical layer, and numerous pits from which former roots once protruded; fracture hard and horny; internally, grayish yellow with cortex 3 to 4 mm. thick and central cylinder with 3 or 4 circles of small, nearly circular fibrovascular bundles.

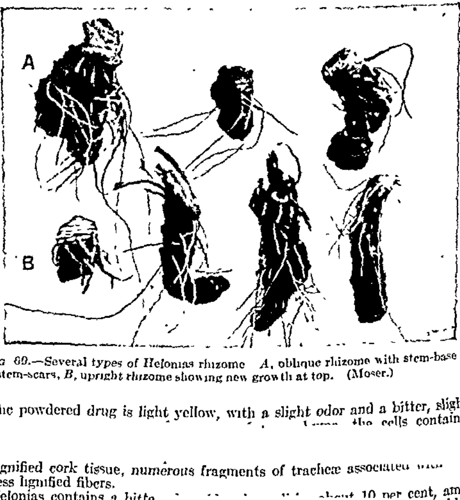


FIG 69.—Several types of Helonias rhizome *A*, oblique rhizome with stem-base and two stem-scars, *B*, upright rhizome showing new growth at top. (Moser.)

The powdered drug is light yellow, with a slight odor and a bitter, slightly ... the cells containing

of lignified cork tissue, numerous fragments of tracheæ associated with ... or less lignified fibers.

Helonias contains a bitte ... about 10 per cent, amorphous, soluble in water, the ... with dilute acids it forms a resinous bo ... le in water. The "Eclectic" extract known as helonin is a hydro-alcoholic extract of the drug and is a mixture of principles

Helonias is a diuretic and uterine tonic. Average dose, 2 gm.

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Trillium or Bethroot (N. F. 1916 to 1947) consists of the dried rhizome and roots of *Trillium erectum* Linné or other species of *Trillium*.

The plant is a low perennial herb growing in rich woods from Canada to North Carolina, producing a rather stout stem, having three leaves arranged in a whorl at the summit and subtending the large, sessile, dark purple flowers which have an unpleasant odor. Trillium was used by American Indians in parturition from which the name "birthroot," contracted into "bethroot" has

to 5 cm. in length and 3 cm. in width;
by a bud surrounded by the bases of
the scarius bud-scales, annulated by scale scars; stem scars few; externally yellowish to reddish or dark brown; internally whitish or pale yellow; fracture
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The powdered drug is nearly white; odor distinct; taste bitter and acrid, producing a sialagogue effect; numerous, simple, spherical starch grains up to 20 microns in diameter, occasionally larger; raphides of calcium oxalate up to 60 microns long, occasionally much longer; tracheæ few, reticulate or spiral, rarely over 26 microns wide; fragments of thin-walled parenchyma, and of reddish brown epidermal and hypodermal cells with unevenly thickened walls

Trillium contains a saponin (trillin) about 5 per cent, considerable starch, and a small quantity of volatile oil.

Trillium has been used as a uterine stimulant but is of questionable value Average dose, 2 gm.

DIOSCOREACEÆ, OR YAM FAMILY

These are mostly twining plants with large tuberous roots or knotted rootstocks. There are about 175 species, most of which are indigenous to the West Indies and South America. The anatomy of the stems is interesting in that the fibrovascular bundles are collateral and arranged in a manner similar to those found in dicotyledons. In the rhizomes the fibrovascular bundles are of a collateral type but are separated from each other, as is usual in the monocotyledons.

Dioscorea or Wild Yam Root (N F 1916 to 1942) is the dried rhizome of *Dioscorea villosa* Linné.

The plant is an herbaceous twining perennial, with beautiful, cordate, 9- to 11-ribbed leaves, small greenish yellow flowers and triangular winged capsules It is common in the eastern and central United States and is easily cultivated Commercial supplies come largely from Virginia, North Carolina, Indiana and Michigan

The rhizome is knotted and woody, elongated, 6 to 20 mm. thick, often compressed, bent and branched, bearing stem-scars on the upper surface, and
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ish.

The powdered drug is nearly white and odorless, taste starchy, insipid but becoming acrid. It contains numerous fragments of thick-walled, lignified parenchyma cells, many of which contain spherical or ovoid starch grains up

to 35 microns in diameter; numerous isolated starch grains and a very few raphides of calcium oxalate; a few fragments of thin-walled parenchyma cells; fragments of fibrovascular bundles with tracheæ and tracheids, which have minute bordered pores; yellowish or brownish fragments of epidermal tissue; a few isolated lignified fibers.

The drug contains an acrid resin and a principle allied to saponin; total ash from 1.35 to 3 per cent, and acid-insoluble ash about 0.2 per cent. Continued boiling is said to impair the acrid properties of the drug.

Dioscorea is a diaphoretic and an expectorant. Average dose, 4 gm.

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Arrowroot.

IRIDACEÆ, OR IRIS FAMILY

These plants are mostly perennial herbs with erect, bilateral leaves, and interesting, frequently handsome flowers. There are about 800 species, occurring in both temperate and tropical climates. Some have rhizomes (*Iris*) which are creeping and the fibrovascular bundles are of concentric type, being of the collateral type only as they enter the leaves; others, like *Crocus*, have a corm. Of special interest is the fact that the calcium oxalate occurs in the form of long styloids, which are surrounded with mucilage, and the walls of the cells in which they are enclosed are suberized.

Several of the genera (*Iris, Crocus, Gladiolus*) are widely cultivated for the beauty of their flowers.

CROCUS

Crocus or Spanish Saffron (U S. P. 1820 to 1905; N. F. 1916 to 1942) is the dried stigma of *Crocus sativus* Linné.

The plant is a low-growing, perennial herb, producing its flowers in the autumn from buds on the large corm. The flowers are 25 mm. or more across, lily-like, and the three stigmas terminate a long style. The flowering period extends over two or three weeks, the flowers being gathered as they open; the dark red stigmas are separated by hand and are dried over charcoal fires, with a loss in weight of about 80 p...
are required to make a kilo of ...
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ancient Greeks
Saffron seems

... Figure 70.
crocin, of which 1 part in 100,000 parts
ution; also another glycoside, picrocrocin, which hydrolyses to form a volatile oil, about 1 per cent of the dried drug, and which gives the characteristic odor to the drug; it also contains wax, fixed oil and dextrose.

Crocus meets the following standards:

1. Contains not more than 10 per cent of the yellow styles of the plant, or 2 per cent of other foreign organic matter
2. Yields not more than 7 5 per cent of total ash, or 1 per cent of acid-insoluble ash.

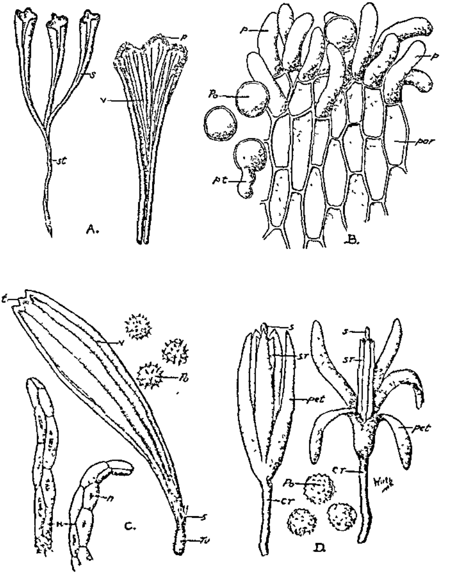


FIG. 70.—A, *Crocus sativus*, showing the three cornucopia-shaped stigmas (s) attached to the style (st), and the upper portion of the stigma enlarged to show venation (v) and

3. Contains not more than 14 per cent of moisture.
4. Imparts a yellow color to water, alcohol, methanol, ether and chloroform, but not to xylene, benzene or carbon tetrachloride.
5. This color is removed by filtration through charcoal (*absence of coal tar dyes*).
6. When pressed between white filter paper, no translucent oily spots appear (*absence of fixed oil or glycerine*).
7. Ligulate or tubular florets and spinose pollen grains under microscopic examination are absent (*florets from the Compositæ*).
8. A 1 in 10,000 filtered macerate of crocus in water approximates that of hundredth-normal potassium dichromate, both in tint and strength of color (*exhausted saffron or artificial coloring*).
9. In sulfuric acid the stigmas immediately become blue, gradually change to purple, and finally to purplish-red. Composite florets do not assume such coloring.

The usual adulterants are indicated above.

Crocus has been used as a diaphoretic, an emmenagogue, and to promote eruption in measles, but its use for these purposes, other than as a domestic remedy, has been abandoned. Its employment today is principally as a coloring and flavoring agent.

Carthamus, American Saffron, Safflower or Indian Safflower (U. S. P. 1820 to 1882) is the tubular florets of *Carthamus tinctorius* (Fam. *Compositæ*). Its characteristics are shown in Figure 70, *D*. It is of a lighter red color than Crocus, but may be admixed with it and is frequently substituted for it. Carthamus is used medicinally for about the same purposes as crocus.

ORRIS

Orris, or Orris Root (U. S P. 1820 to 1873; N. F. 1916 to date) is the peeled and dried rhizome of *Iris florentina* Linné, *Iris germanica* Linné, or *Iris pallida* Lamarck. Iris is from the Greek, meaning goddess of the rainbow, and alludes to the varied colors of the flowers; *florentina* relates to the city of Florence; *germanica*, of Germanic origin; and *pallida* from the Latin *pallidus*, pale, referring also to the color of the flowers.

The plant consists of a horizontal branching, thick, annulated rhizome bearing numerous broad sword-shaped leaves and long-peduncled flowers. In *Iris germanica* the sepals are dark violet-purple with a yellow beard and three lilac-colored petals about the same size as the sepals. The flowers of *Iris pallida* are pale blue-white; *Iris florentina* produces large white flowers and has the most fragrant root. *Iris germanica* and its varieties are cultivated almost universally as garden plants. Production of orris root takes place largely in Italy, although some is produced in France, Germany and in northern Africa. The rhizomes are dug in the early fall, those from three-year-old plants being preferred. The leaves and roots are removed and the rhizomes peeled and allowed to dry slowly in the sun, during which the fragrant odor is developed. There are two principal varieties, Florentine and Verona, the former being preferred. Orris root was employed in perfumery in Greek and Roman times. During the Middle Ages, Florence was an important source of the drug, the coat of arms of that city bearing a white iris against a red shield.

Description, Structure and Powder.—See Figure 71 and the National Formulary.

Constituents.—Orris "butter," a yellowish concrete volatile oil, 0.1 to 0.2 per cent, consisting mostly of myristic acid, and which owes its very fragrant odor to the ketone, irone, iridin, a crystalline glucoside, soluble in hot alcohol; an acrid resin and some tannin.

[illegible] er cent of foreign organic matter, nor more [illegible] id [illegible] ry [illegible] liming.

Uses.—Powdered Orris Root is used in dusting powders, sachet powders, dentifrices, and toilet powders. The volatile oil is used in perfumery, both as a fixative and in violet combinations.

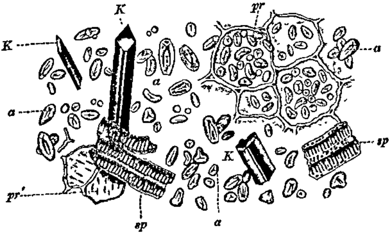


Fig. 71.—Powdered Orris Root. Light yellow with numerous fragments of starch-bearing parenchyma (*pr*), starch grains (*a*) ovoid, oval, truncate, some curved or with irregular protuberances, mostly single, from 10 to 50 microns in length, and with X- or scissors-shaped cleft in the large rounded end of the grain, two of the fissures extending into the small end of the grain, tracheæ (*sp*) showing spiral, annular, reticulate or scalariform markings, and up to 25 microns in width, parenchyma (*pr'*) with narrow oblique pores, calcium oxalate in prisms (*K*) up to 500 microns in length and 30 microns in width (After Vogl.)

Blue Flag (U. S. P. 1820 to 1895, N. F. 1916 to 1942) is the dried rhizome of *Iris versicolor* Linné, or of *Iris virginica* Linné. The plant is herbaceous, growing in low swampy places in eastern and central North America. The rhizomes are freed from the scaly decayed leaves and roots, frequently sliced lengthwise, and dried.

The rhizome is cylindrical, more or less flattened, occasionally branched; outer surface annulate with numerous stem-scars on the upper surface and numerous root-scars on the lateral and under portions; externally grayish brown to blackish brown and occasionally with the fibrous bases of decayed leaves and short fragments of the stout roots; fracture short, resinous, internally reddish brown, with a distinct yellowish endodermis and numerous, whitish, scattered vascular bundles (see Fig. 72). The powdered drug is pale reddish brown, odor slightly aromatic, taste sweetish, bitter and slightly acrid, calcium oxalate in solitary prisms up to 350 microns long, tracheæ with spiral or reticulate markings; parenchyma with numerous resin cells, amylodextrin grains small, colored reddish with iodine; true starch grains rare.

Blue Flag contains about 25 per cent of acrid resins and a small quantity of volatile oil. Total ash, about 3.5 per cent. "Irisin" or "iridin" is a mixture of the resins from the drug.

Blue Flag contains not more than 5 per cent of attached roots and leaf-bases and not more than 2 per cent of other forei
more than 2 per cent of acid-insoluble ash.
considerably owing to the lack of uniformity
are apparently very labile, the resins becomi
substances.

Blue Flag is a cathartic, also an emetic and a diuretic. Average dose, 2 gm.

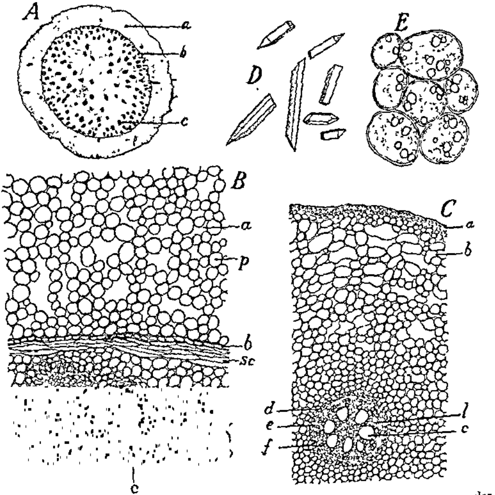


Fig. 72.—Rhizome of *Iris versicolor*. *A*, diagram of transverse section showing vascular bundles (*a* and *c*), endodermis (*b*). *B*, portion of rhizome showing parenchyma (*p*);

ZINGIBERACEÆ, OR GINGER FAMILY

This family consists of about 300 species of perennial herbs characterized by long or tuberous rhizomes and strongly thickened roots. They are indigenous to the tropics of the eastern hemisphere, especially

the countries bordering the Indian Ocean and Malay Islands, only two of the genera being found in tropical America. The leaves are lanceolate and ligulate at the basal portion of the petiole. The walls of the cells of the endodermis are thin and mostly suberized. The plants usually contain a volatile oil colored yellow by curcumin, and found in special secretion cells which resemble the surrounding parenchyma. The starch grains are quite characteristic, having a distinct acute termination or beak near the hilum.

GINGER

Ginger (U. S. P. 1820 to date) is the dried rhizome of *Zingiber officinale* Roscoe known in commerce as Jamaica Ginger and African Ginger. *Zingiber* is from the Arabic *Zindschebil*, meaning root of *Zindschi* (India). The specific name refers to its being for sale in the shops.

While the U. S. Pharmacopœia did not distinguish the several commercial kinds of ginger in the revisions from 1820 to 1882, yet a quotation from the U. S. Dispensatory of 1833 indicates that several commercial varieties were in use: "The *common, East India or black ginger* is dark ash color or almost black. It is most extensively used in the United States. The *Jamaica or white ginger* is entirely deprived of its epidermis and is white or yellowish-white on the outside. It produces a beautiful yellowish-white powder and has more of the sensible qualities of ginger than the black variety."

In the Pharmacopœias of 1882, 1894 and 1905 the definition required that the rhizome be "deprived of the corky layer," indicating Jamaica ginger.

In the U. S. P. of 1916, Jamaica, limed Jamaica, African, Cochin, Calcutta, Calicut, and Japanese gingers were recognized by name.

In the U. S. P. of 1926, Jamaica, African and Cochin gingers were recognized.

African Ginger is not so completely peeled as is Jamaica ginger, it may be scraped on its two lateral surfaces, is darker in color, both externally and internally, more pungent in taste and with a less delicate flavor than the Jamaica ginger.

Cochin Ginger somewhat resembles African ginger, but is usually larger, well scraped, contains more starch and breaks with a shorter fracture.

Calcutta and Calicut Ginger (possibly the same) resemble African, but are somewhat larger and more [illegible].

Japanese Ginger is [illegible] from *Zingiber* [illegible]. The rhizome is usually limed and is considerably smaller and less pungent than Jamaica ginger; it has a [illegible] larger [illegible].

Martinique Ginger, former U. S. P., is said to be derived from *Zingiber* [illegible].

Preserved Ginger is the peeled, fresh rhizome preserved by boiling in syrup. The West Indian product is used as a delicacy [illegible]. That from China is said to be prepared from Galanga[illegible].

The ginger plant (see Fig. [illegible]) is propagated in Jamaica by rhizome cuttings which are planted in March and April. The rhizomes are dug and peeled in December and January. After [illegible] peeled, the rhizomes [illegible]

are washed in water for hours, then dried in the sun for five or six days, being covered at night or during rainy weather.

Ginger was known in China as early as the fourth century B.C. It was used as a spice by the Greeks and Romans, who considered it an

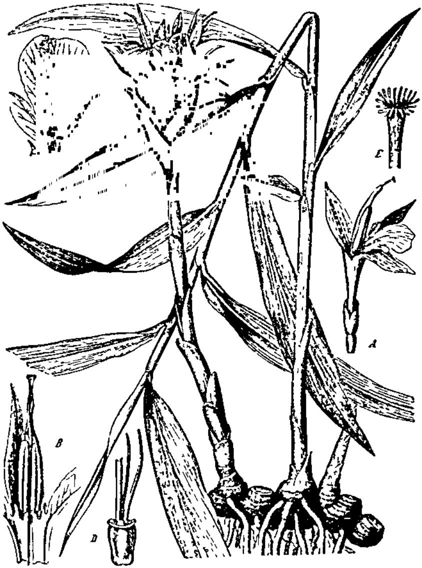


FIG 73 —*Zingiber officinale*, the rhizome of which constitutes the Ginger of the market Entire plant showing rhizome and roots, a leaf-branch and a flower-branch, also scars of previous year's growth after decay of leaf- and flower branches *A*, entire flower, *B*, section of flower sho [illegible] stamen which encloses the style *C* [illegible] tooth-like staminodes (ru [illegible] tion of style and two epigynous filiform processes which secrete nectar, *E*, summit of funnel-shaped, fringed stigma (After Berg and Schmidt.)

Arabian product because it came to the [illegible] from India by the way of the Red Sea. From the ele [illegible] it was a common import from the East. [illegible] and India, 1280-90 Ginger was introduced into Jamaica and other

islands of the West Indies by the Spaniards, and exports from the West Indies to Spain appear in considerable quantity as early as 1547.

Description, Structure and Powder.—See Figure 74, and the U. S. Pharmacopœia.

Constituents.—Ginger contains a volatile oil (1 to 3 per cent) to which its aroma is due; a viscid oily resinous liquid known as "gingerol" (0.5 to 1.5 per cent) to which its pungency is due, resins, starch and mucilage. Gingerol consists of several homologous phenols which are destroyed by boiling with dilute alkalis.

Standards. Ginger contains not less than 42 per cent of starch, not more than 8 per cent of crude fiber, not more than 1 per cent of lime (CaO), not less than 12 per cent of cold water extractive, not less than 4.5 per cent of ether-soluble extractive, not less than 2 per cent of non-volatile ether extractive, not more than 7 per cent of total ash, not more than 2 per cent of ash insoluble in hydrochloric acid, and not less than 2 per cent of ash soluble in cold water. Limed ginger (bleached ginger) contains not more than 4 per cent of CaO and not more than 10 per cent of total ash, and conforms in other respects to the above standards.

Uses and Dose. Ginger is a condiment, an aromatic stimulant and a carminative. Average dose, 0.6 gm.

Adulterants.—Since the strict enforcement of the National Pure Food and Drug law, adulterated ginger seldom appears in American commerce. Previous to the enforcement of this law, ginger, especially when powdered, was subject to extensive adulteration. Among the adulterants were starches, cereal products, sawdust, curcuma to restore color, capsicum to increase pungency, exhausted ginger, and excessive liming. Unpeeled gingers contain numerous corky fragments.

The most dangerous adulterants ever known in commerce were tricresyl phosphate and triethylene glycol added to a "cheap" fluid ginger of high alcoholic concentration and sold to alcohol addicts during the prohibition era in the United States. Before enforcement officials had discovered and stopped this adulteration perhaps 16,000 persons suffered from paralysis or death from drinking this concoction.

Galangal or Galanga (N. F. 1916 to 1936) is the rhizome of *Alpinia officinarum*, a plant indigenous to the countries of eastern and southeastern Asia and culti-

10 cm. in length and from 7 to 20 mm. in diameter, externally it is reddish brown, the odor is aromatic, and the taste is aromatic and pungent.

The powder is reddish brown and displays numerous ellipsoidal, ovoid, more or less spatulate starch grains from 10 to 60 microns in length, having a circular hilum at the broad end and indistinct lamellæ; numerous yellowish red secretion cells frequently separated from the starch-bearing parenchyma, non-suberized

Galangal contains from 0.5 to 1 per cent of a cineol-containing volatile oil; a soft acrid resin containing a pungent principle, galangol; three yellowish crystalline principles, alpinin, galangin, and kæmpferid, each occurring to the extent of about 0.1 per cent; starch from 20 to 25 per cent, and ash, containing manganese, 4 per cent.

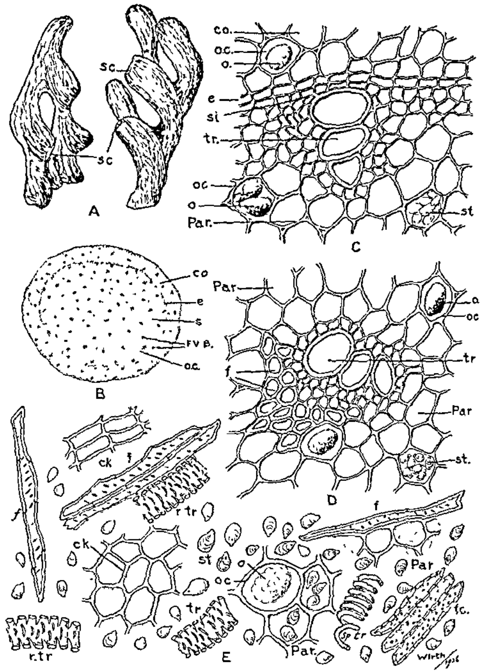


FIG. 74 —Jamaica Ginger ... to 20 mm in tl ... scars (*sc*) at the ... yellowish to lig ... and have ... transverse secti ... the endo- derm ... ndodermis; *s*, ce ... tracheæ; *f*, fibers ...

... cork cells (*ck*) should be absent. (Drawings by Wirth.)

Galangal is an aromatic stimulant, a condiment and a carminative. Average dose 1 gm.

Zedoaria or Zedoary (N. F. 1916 to 1936) is the dried rhizome of *Curcuma zedoaria*, a plant cultivated in southeastern Asia, Madagascar and other tropical countries. It is exported mostly from Ceylon and Madras.

The rhizome, before drying, is cut transversely into nearly circular disks. When dried these are 1 to 4 cm. in diameter and 4 to 10 mm in thickness, nearly white on the cut surfaces and yellowish brown on the edge; fracture short and mealy; odor aromatic and camphoraceous, taste pungent and somewhat bitter.

ash and small quantities

Average dose, 1 gm.

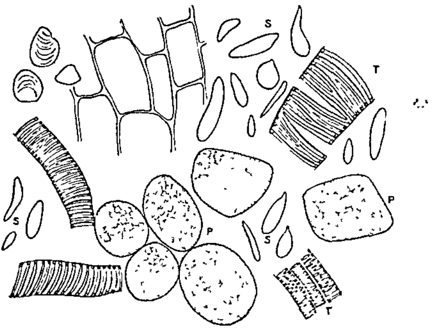


Fig. 75.—Curcuma (Turmeric) *P*, fragments of parenchyma containing curcumin and swollen and altered starch grains which form an indistinguishable mass within the cells and constitute the greater proportion of the powder. *T*, tracheæ. *S*, unaltered starch grains

Curcuma or Turmeric (U S P. 1820 to 1882) is the prepared rhizome of in many tropical countries, prin- ilar to those used in the cultiva- the end of the growing season, cleaned, boiled for some hours, and then carefully, but rapidly, dried in the open air.

"Round Curcuma," from the swollen internodes, is ovoid and up to 2 cm. thick; "Long Curcuma," from the fleshy rhizome branches, is cylindrical or fusiform and up to 5 cm. long. The drug is orange yellow in color, somewhat darker externally; odor aromatic; taste pungent and somewhat bitter.

The parenchyma cells of cortex and pith contain curcumin and starch paste, in which long, lens-shaped, unaltered starch grains are occasionally present. The oil cells have suberized walls and contain colored volatile oil globules and resin masses.

The powder is bright yellow; see Figure 75.

from 30 to 40 per cent of starch; 4 to 7 per cent of ash; and a small quantity of a fixed oil.

Curcuma is used as a coloring agent and a condiment and is also an aromatic stimulant and carminative. Average dose, 0.5 gm.

Powdered turmeric is extensively used as a coloring agent for mixtures of powders and for certain food preparations, particularly "Prepared Mustard" Its principal microscopic identi[illegible] curcumin and which are bright [illegible] treatment with alkali, crimson [illegible]

As alternative tests for the d[illegible]

1 Place a few drops of a mixture of equal parts of concentrated sulfuric acid and 95 per [illegible] Sprinkle a small qu[illegible] with the hand lens: [illegible] y flowing out into the surrounding liquid.

2. Stir a small quantity of the suspected powder into a thin paste with a mixture of ether and chloroform. Allow this paste to dry on filter paper and when dry remove the powder and treat the remaining yellow stain with hot saturated boric acid solution. An orange-red color is produced which turns bluish black upon the addition of ammonia, if curcurma is present.

CARDAMOM

Cardamomum (U. S. P. 1820 to 1916) and **Cardamomi Semen**, or **Cardamom Seed** (U. S P. 1916 to date) is the dried ripe seed of *Elettaria Cardamomum* Maton, recently removed from the capsules.

Cardamom fruit was recognized on the basis that the seed deteriorated less rapidly when preserved within the capsule; it is the seed that has been used, after recent removal from the capsules, throughout the whole period of Pharmacopœial recognition.

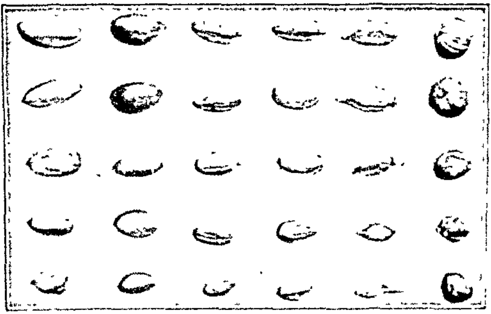
Eletteria is the native name of the plant in Malabar; *cardamomum* is the ancient classical name for the spice.

The plant is a reed-like perennial herb rising 2 to 3 meters high from a thick horizontal rhizome, bearing long lanceolate leaves and short scapes with racemes of greenish white flowers. It is cultivated in Indo-China, Ceylon and along the Malabar coast. The fruits are collected mostly from October to December as they ripen. They are sun-dried, bleached with sulfur dioxide and graded, those with a split capsule furnishing separated seed for the distillation of the oil.

Cardamoms were mentioned in the early Sanskrit writings of Susruta and appear in the list of [illegible] .D. 176 to 180. The Portugue[illegible] finitely described them as a pro[illegible] of their introduction into Europe is difficult to determine as many of the cardamoms mentioned in early writings may have been Amomums.

Cardamom Fruit are ovoid capsules, 1 to 2 cm. in length, loculicidally dehiscent and of a light tan color. Unbleached fruit are darker and blotched.

The fruit are graded according to size and shape into "longs, short-longs, mediums, shorts and tiny." Commercially they are classed according to the district where they originated (1) Mysore, principally obtained now from Mysore-type of plants grown in Ceylon; (2) Malabar, obtained largely now from Malabar-type plants cultivated in Ceylon; (3) Mangalore, on the Malabar coast; and (4) Alleppy, grown in Travancore and Cochin. The Ceylon fruit grade the highest in quality.



A B C D E F

[illegible] Mysore; B, Malabar; C, Mangalore; D, Malabar; [illegible]

DESCRIPTION, HISTOLOGY AND POWDER.—See Figures 76, 77 and the U. S. Pharmacopoeia.

CONSTITUENTS.—Of the seed, volatile oil 3 to 6 per cent, fixed oil, about 10 per cent, starch, calcium oxalate, [illegible] ash 4 to 8 per cent. It yields not more than 3 per cent of acid-insoluble ash.

USES.—Cardamom seed is an aromatic [illegible]

Cardamom Oil (N. F. 1916) [illegible] cardamom seed.

DESCRIPTION, TESTS AND STANDARDS.—See the National Formulary.

ADULTERANTS.—**Cardamom Seed**, [illegible]

ALLIED PLANTS.—**Ceylon Cardamom** is obtained from wild plants of *Elettaria cardamomum* var. *major*. The capsules are 2 to 4 cm. long and about 10 mm. in diameter, distinctly triang...
striate and slightly pubescent ...
are about 4 mm. long, bitter a ...

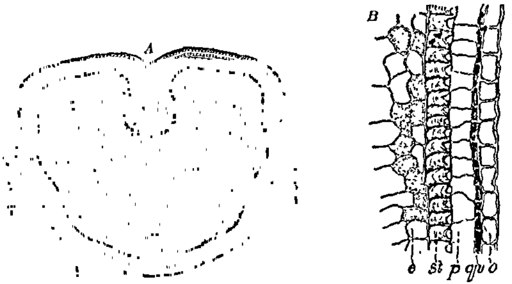


FIG 77 —Cardamom Seed *A*, transverse section showing the arillus (*h*), the several layers of the seed coat (*T*, *l*, *V*... and embryo (*S*) at the center. *B*, transverse section of the ... epidermal cells (*o*), cells hav... (*p*), brown stone cells (*St*) with ... *B*, after Moeller.)

Siam Cardamom (see Fig. 76) is obtained from *Amomum cardamomum* growing in Siam and Java, and known as cluster cardamoms; *Amomum xanthoides* yields the **bastard** or **wild Siamese Cardamom**; *Amomum aromaticum* yields the **Bengal** and **Nepal Cardamoms** and *Amomum maximum* the **Javanese Cardamom.**

Grains of Paradi... and
in tropical Africa. ...
testa and possess a ...
paradol, a substance very closely related to gingerol. Other African species of *Aframomum* yield cardamom-like fruits among which the following might be mentioned: **Abyssinian Cardamom** from *A. korarima:* **East African Cardamom** from *A. mala;* **Cameroon Cardamom** from *A. hanburii;* and **Madagascar Cardamom** from *A. angustifolium.*

MARANTACEÆ, OR ARROWROOT FAMILY

Plants of this family are mostly perennial herbs having thick fleshy rhizomes or tubers. They are found mostly in the tropics and are represented by about 150 species. The leaves are long-petioled and characterized by a swollen, long, sac-like sheath at the base. Sections of the leaf show a hypodermis with unusually large cells. The petiole of the stem contains large lysigenous lacunæ, and star-shaped parenchyma is developed in the diaphragms. Calcium oxalate occurs in the form of rod-like crystals.

Maranta, Arrowroot Starch, Bermuda Arrowroot, or St. Vincent Arrowroot (U. S. P. 1820 to 1882; as reagent, U. S. P. and N. F. 1936 to date) is the starch obtained from the rhizome of *Maranta arundinacea*, a plant indigenous to the West Indies and northern part of South America, and now extensively cultivated in nearly all tropical countries.

One-year-old rhizomes are collected, washed, beaten into a pulp, mixed with water, and the starch removed by filtering through copper sieves; this is then carefully dried. The commercial supplies come chiefly from St. Vincent and Bermuda. The yield is about 20 per cent of dried starch from the fresh rhizomes.

granules or masses, from 1 to 6 mm
in oth powder, which is velvety to the
to lipsoidal to ovoid or oblong, 10 to 65

play of colors when a selenite plate is used.

Maranta contains about 10 per cent of water and less than 1 per cent of ash. It enters largely into infa
possible from impurities.
hydrochloric acid for ten
filtering, the starch gran
mucilaginous, nor should an unpleasant odor be emitted. When examined on the thermo-stage of the microscope the granules begin to swell at 70° C One part of starch heated to 100° C with 20 parts of distilled water gives a trans-

(Fig. 46).

The name arrowroot is applied to the starches obtained from a number of different plants **Tahiti Arrowroot** is obtained from *Tacca pinnatifida;* **East Indian Arrowroot** is prepared from several species of *Curcuma;* **South Sea Island Arrowroot** is obtained from several species of *Arum* and *Dioscorea;* **Brazilian Arrowroot** is identical with cassava or tapioca starch.

ORCHIDACEÆ, OR ORCHID FAMILY

On account of the remarkable beauty and delicacy of the flowers, this family, comprising about 12,000 species, is probably the most interesting group in the entire plant kingdom. The species are widely distributed, although most abundant in the tropics They are sometimes classified according to habit of growth, as saprophytic, epiphytic and terrestrial Most of the orchids common to the United States are either saprophytic or terrestrial plants The epiphytic orchids are characteristic of the tropics and are by far the most valuable of the orchids They are sometimes spoken of as parasitic, but this is erroneous, as none of the members of this family is parasitic. The stems show a characteristic monocotyledonous structure Mucilage, in the form of a cell-content, occurs in those genera producing tubers. Similar mucilage cells are also found in the leaves, and also in the roots of the epiphytic forms.

VANILLA

Vanilla or **Vanilla Bean** (U. S. P. 1863 to 1916; N. F. 1916 to date) is the cured, full-grown, unripe fruit of *Vanilla planifolia* Andrews, known in commerce as Mexican or Bourbon Vanilla, or of *Vanilla tahitensis* Moore, known in commerce as Tahiti Vanilla. *Vanilla* is from the Spanish *vania*, a sheath-like pod, and *illa*, small; *planifolia* from the Latin *planus*, flat, and *folium*, leaf; *tahitensis*, in reference to Tahiti, its adopted home.

The plants are perennial, climbing, dioecious epiphytes attaching to the trunks of trees by means of aerial rootlets. The plant is native to the woods of eastern Mexico but is cultivated in tropical countries where the temperature does not fall below 18° C. and where the humidity is very great.

The plant is usually propagated by means of cuttings and after two or three years reaches the flowering stage, continuing to bear fruit for thirty or forty years. The flowers are hand-pollinated, about 30 flowers on each plant, thus producing larger and better fruits. The fruits are collected as they ripen to a yellow color, six to ten months after pollination and are cured by dipping them in warm water and repeatedly sweating them between woolen blankets in the sun during the day and packing them in wool-covered boxes at night. This requires about two months, during which the pods lose from 70 to 80 per cent of their original weight and take on the characteristic color and odor of the commercial drug. The pods are then graded, tied into bundles of about 50 to 75, and these are sealed in tin containers for shipment.

The Spaniards found vanilla in use as a flavor for cocoa among the Aztecs of Mexico and introduced its use into Europe. Cultivation was begun in Reunion in 1839, and followed shortly after in other countries.

Description and Structure.—See Figure 78 and the National Formulary. Tahiti Vanilla, grown in Tahiti and Hawaii, is reddish brown in color, about as long as the Mexican but sharply attenuated and twisted in the lower portion. The odor is somewhat unpleasant and the variety is somewhat unsuitable for flavoring.

Constituen [illegible] ...llin (vanen-
ein) and gluc [illegible]
during the cur [illegible]
hydrolyzed int [illegible]
aldehyde (van [illegible]
contains about [illegible]

Standards.- [illegible]
soluble in diluted alcohol.

Upon heating vanilla, a microsublimate of vanillin forms in droplets which crystallize into tufts upon rubbing, and may be readily identified by microchemical tests (page 188).

Place a few of the crystals occurring as an efflorescence on the fruit of a microscopic slide or watch crystal, add a drop of phloroglucinol T.S. and a drop of hydrochloric acid: the solution immediately acquires a carmine-red col [illegible] ...pods or pods
of [illegible] ...mulate
a [illegible] ...ted by
[illegible] well as coumarin [illegible]
their micromelting points (see Fig. 80).

USES.—Vanilla is extensively used as a flavoring agent. It has been replaced to some extent, but by no means completely by synthetic vanillin. The latter does not completely represent the flavor or odor of the pods.

COMMERCIAL VARIETIES:

Mexican or Vera Cruz Vanilla is the best grade on the market, the pods frequently attaining a length of 30 to 35 cm. The supply is largely consumed in Mexico and the United States.

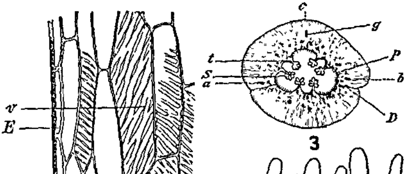


FIG. 78.—Vanilla. *3*, transverse section of an unripe fruit showing the three carpels (*a*, *b*, *c*), line of dehiscence (*D*), placenta (*t*), seeds (*S*), fibrovascular bundle (*g*), papillæ (*P*). *1*, radial longitudinal section of the outer part of the pericarp showing epidermis (*E*), and parenchyma cells with oblique pores (*v*). *2*, tangential longitudinal section of the outer part of the pericarp showing cells with oblique pores (*v*) and spirally thickened bands (*Sp*). *4*, inner layer of the pericarp showing the very long simple hairs or papillæ. (After Meyer.)

Bourbon Vanilla is produced in the Isle of Reunion. It resembles the Mexican variety, but is about two-thirds as long, blacker in color, usually covered with a sublimate of needle-shaped vanillin crystals and possess a tonka-like odor. Most of the supply goes to France, although some reaches the United States via that country.

Mauritius Vanilla, grown in the island of that name and in the Seychelles, occurs in cylindrical pods, somewhat lighter and shorter than Mexican. Most of

factu- cm. long, 1.5 to 2.5 cm. in di what triangular in outline, with transverse markings, due to their being wrapped w curing, when they are spoken of as "braided," plit; the odor is peculiar, somewhat resembling e presence of the aldehyd to vanillin.

Pompona *Vanilla pompona,* which is con *lanifolia* has been derived by a appearance, but the odor is

Vanilla Splits and **cuts** represent the more mature fruits in which dehiscence has taken p

ALLIED *Vanilla* yield

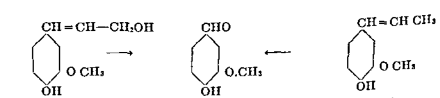
odorous principle coumarin

A number of the orchids g chiefly to the genus *Orchis,* as *Orchis odoratissima* of Europe; *O. coriophora* of Europe and the Orient; *O. simia* of Europe and the Orient; *O. militaris* of Europe and Asia; *Habenaria conopsea* of Europe and Asia; *Aceras anthropophora* of Europe and Arabia.

Vanillin (U. S. P. 1905 to date; as a reagent, U. S. P. 1916 to 1926; N. F. 1926 to date) is methyl protocatechuic aldehyde and may be obtained from vanilla or prepared synthetically from other sources.

PREPARATION.—(1) In the preparation of vanillin from vanilla the pods are ground, mixed with sand and extracted with ether; the ethereal solution is then shaken with sodium sulfite solution from which the vanillin is liberated by treatment with sulfuric acid, expelling the sulfurous acid, extraction with ether a of pine acid. alcoho

yl-vanillin with ed with alkali, st of the vanillin ons.



Coniferyl alcolol Vanillin Isoeugenol

yellow crystals having an odor and taste soluble

may be obtained from its solutions by crystallization on a slide (see Fig. 79).

2. When . . . .
a crystal of
the crystal
dehydro-divanillin will form.
. . . . . . h phenols (phloroglucin, orcin or resorcin)
a crystal of vanillin on a slide. Since,
this reaction care must be employed in

FIG. 79.—Vanillin, orthorhombic crystals obtained from saturated aqueous solution

4. The sublimate c
(a) Potassium hydro
hydrochloric acid giv
1 to 4, gives orange

ADULTERANTS AND SUBSTITUTES.—1. Coumarin (see page 342), the principal constituent of tonka bean, has been used as a substitute for vanillin It may be detected by its low melting-point (about 67°) or by various other microchemical reactions, the most important one being the chlor-zinc-iodide test which gives brownish violet crystalline threads.

2. Benzoic acid has been used to dust inferior vanilla beans. It may be detected by its melting-point (120°), by its solubility in alkalis from which it crystallizes (on the slide) in feather forms when liberated by the addition of
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Cypripedium or Lady Slipper Root (U. S. P. 1863 to 1916; N F. 1916 to 1936) is the dried rhizome and roots of *Cypripedium parviflorum* and *Cypripedium pubescens*, perennial herbs (Fig. 81) native in woods and thickets of the eastern and central United States and Canada.

The rhizome is horizontal, somewhat tortuous and bent, 3 to 10 cm. long, 2 to 6 mm. in diameter; externally dark brown, annulate from scars of bud-scales, the upper surface with numerous large, sometimes repressed scars, the under and side portions with numerous roots and few root-scars.

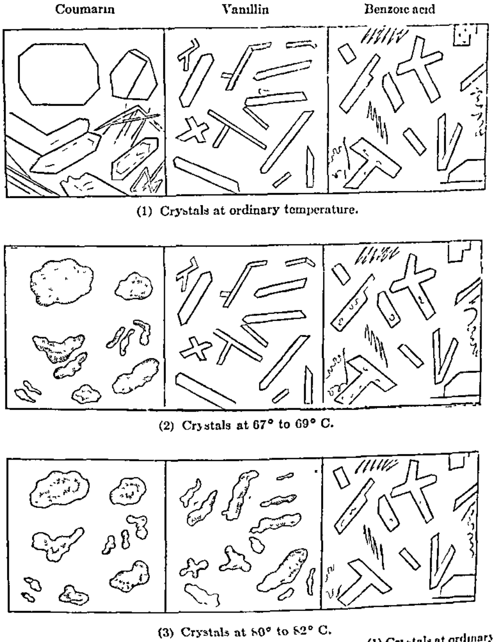

FIG. 80.—Examination of crystals by means of a thermo-stage. (1) Crystals at ordinary temperature (2) Slide heated to 67° to 69° C., at which temperature coumarin melts, but the crystals of vanillin and benzoic acid remain normal. (3) Crystals heated to from 80° to 82° C., at which temperature vanillin melts.

The powder is yellowish or brownish, with calcium oxalate in raphides up to 70 microns in length; starch grains somewhat spheroidal, 2 to 14 microns in diameter, single or compound; tracheæ spiral, scalariform or with simple pores; sclerenchymatous fibers long, thin-walled; parenchyma thick-walled, with numerous simple pores.

Cypripedium contains a volatile oil; several resins, a bitter glycosidal principle; tannin; gallic acid; starch; calcium oxalate in the form of raphides, and ash about 6 per cent.

Cypripedium is occasionally used as a nerve stimulant and an antispasmodic Average dose, 1 gm.

The rhizomes and roots of other species of *Cypripedium* possess properties analogous to the drug just described, and of these the following may be mentioned: *Cypripedium arietinum*, *C. candidum*, *C. hirsutum* and *C. acaule*.

Fig. 81.—*Cypripedium pubescens*. Grown in slat house, Medicinal Plant Garden, University of Minnesota

Salep or Tubera Salep (U. S. P. 1820 to 1831) is the fleshy tuberous roots of
The tubers are collected from
d southwestern Asia and are
At the flowering period the
which the flowering plant is
developed and the other young, firm and fleshy, only the latter ones are used. The tubers are scalded to destroy their vitality and to facilitate drying.

Salep is nearly globular, ovoid or somewhat ellipsoidal, more or less compressed; from 1 to 4 cm in length and from 0.5 to 2 cm. in diameter; externally light yellowish or grayish brown, somewhat translucent, irregularly furrowed but otherwise nearly smooth, and occasionally with a small conical bud at the summit; hard and of a horny texture; inner surface with numerous scattered vascular bundles; inodorous and very mucilaginous (see Fig. 82).

Salep contains mucilage 48 per cent; starch 25 per cent, nitrogenous substances 5 per cent, sugar 1 per cent; ash from 1.5 to 4 per cent; and a trace of volatile oil

Salep is a demulcent and a nutrient. Average dose, *ad libitum.*

Radix Palmæ Christi are the flattened 2- to 5-branched salep tubers, but these do not contain as much mucilage, though they are sometimes seen in the

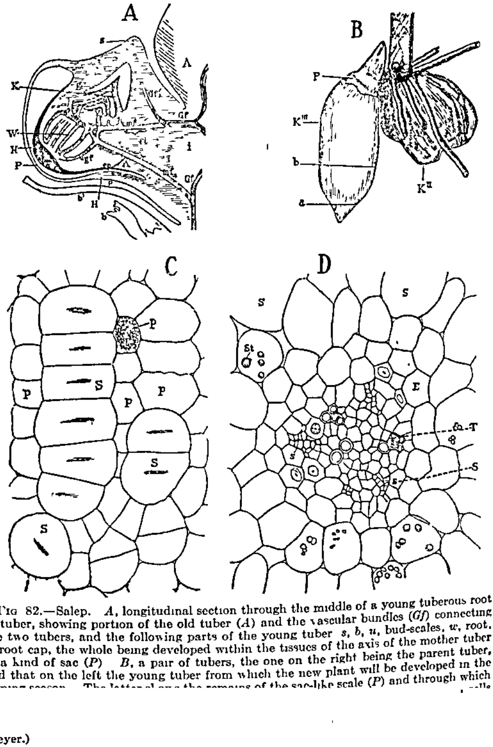

Fig 82.—Salep. *A*, longitudinal section through the middle of a young tuberous root or tuber, showing portion of the old tuber (*A*) and the vascular bundles (*Gf*) connecting the two tubers, and the following parts of the young tuber *s*, *b*, *u*, bud-scales, *w*, root, *h*, root cap, the whole being developed within the tissues of the axis of the mother tuber in a kind of sac (*P*) *B*, a pair of tubers, the one on the right being the parent tuber, and that on the left the young tuber from which the new plant will be developed in the [illegible] The latter [illegible] the remains of the sac-like scale (*P*) and through which [illegible]

Meyer.)

drug of commerce. The **Royal Salep** of Afghanistan is edible and is derived from *Allium macleanii.*

DICOTYLEDONEÆ—DICOTYLEDONS

The plants of this class present the highest development in the plant kingdom and comprise about three-fourths of the living Angiosperms. They are characterized by having two seed-leaves or cotyledons in the embryo. The foliage leaves are usually bilateral and reticulately veined. The flowers are usually tetramerous or pentamerous. The roots and the stems are characterized by a distinct cambium, therefore secondary growth of the wood and the bark is usual and a secondary cork by means of a phellogen is not unusual. The stems of secondary growth show a ring of open collateral fibrovascular bundles radially arranged about a central pith. The class includes herbs, shrubs and trees.

PIPERACEÆ, OR PEPPER FAMILY

Most of the members of this family are herbs and shrubs which have secretory cells in the stems and leaves. In the latter they are conspicuous as small transparent dots. The species of *Piper*, comprising more than one-half of the members of the family, are mostly shrubs having swollen nodes and fleshy spikes of flowers. The leaves are opposite and bifacial, having stomata on the lower surface only. Non-glandular and glandular hairs may be present. The fruit is a drupe, enclosing a seed containing endosperm and abundant perisperm.

CUBEB

Cubeb or Cubeb-Berries (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried, nearly full-grown, unripe fruit of *Piper cubeba* Linné filius. The plant is a woody climber indigenous to Borneo, Java and Sumatra, where it is also cultivated, being trained upon the trees used as shade for coffee trees. The specific name *cubeba* is the native term for the plant. The fruit is gathered when nearly full-grown but still green, and carefully dried in the sun, the commercial supplies being shipped from Batavia and Singapore. Arabian physicians of the ninth and tenth centuries were acquainted with the medicinal properties of cubeb. The fruits were used as a spice in Europe as early as the eleventh century, but did not regain medicinal usage until the beginning of the nineteenth century. Since 1818 they have been included in most pharmacopœias.

Description, Structure and Powder.—See Figures 83 and 84 and the National Formulary.

Constituents.—By steam distillation cubeb yields 10 to 18 per cent of **Oil of Cubeb** (*U. S. P. 1842 to 1926*), a volatile oil consisting chiefly of terpenes and sesquiterpenes and a sesquiterpene hydrate known as cubeb camphor. Cubeb also contains 2.5 to 3.5 per cent of resins, 1 to 3.5 per cent of cubebic acid; 0.4 to 3 per cent of a bitter crystalline principle, cubebin; 1 per cent of fixed oil; 8 per cent of gum, starch; and about 6 per cent of ash. Cubebin and cubebic acid are colored red by sulfuric acid.

Standards and Tests.—Cubeb contains not more than 10 per cent of its shriveled fruit or 5 per cent of its stems, not more than 2 per cent of other foreign organic matter, and yields not less than 13 per cent of volatile cubeb oil, and not more than 2 per cent of acid-insoluble ash. Cubeb, powdered or crushed, mixed [illegible]

Uses and Do[illegible]
and a carminati[illegible] Average dose, 2 gm.

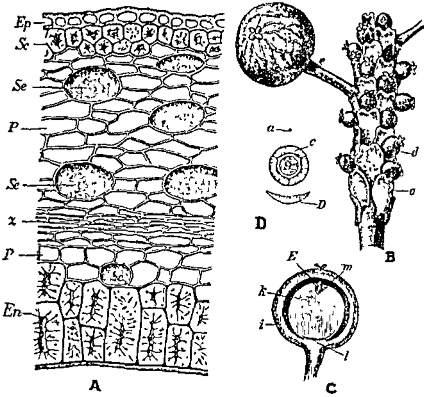

Fig. 83.—Cubeb. *A*, transverse section of the pericarp showing epidermis (*Ep*), stone cells (*Sc*), oil cells (*Se*), parenchyma (*P*), collapsed parenchyma tissue (X), endocarp (*En*) composed of stone cells. *B*, spike showing bracts (*a*), young sessile fruits (*d*), and a mature fruit with long pedicel (*e*). *C*, longitudinal section of mature fruit showing pericarp (*i*), union (*l*) of seed and pericarp, large perisperm (*k*), small endosperm (*m*), which surrounds the embryo (*E*). *D*, flower diagram showing the position of the flower in reference to the rachis (*a*), bract (*D*) and pericarp (*c*) which surrounds the ovule (*S*). (After Meyer.)

Adulterants and Allied Plants.—The fruits of other species of *Piper*, particularly *P. ribesoides*, sometimes find their way into market; *Piper cubeba* var. *rinoe badak*, exhibits st[illegible] These fruits are grayish in color, larger, [illegible] he sulfuric acid test, together with ana[illegible] these and other allied species from genuine cubeb.

A number of other species of *Piper* yield fruits resembling cubeb, as *P. clusii*, of West Africa; *P. borbonense*, of Bourbon; *P. sumatranum* and *P. pedicellosum*, of Indo-China.

The fruit of *Toddalia lanceolata* (Fam. *Rutaceæ*) is used in Africa in place of cubeb. The fruits of *Litsea citrata* have been sold as False Cubeb, and those of [illegible] hin China.

I[illegible] nd this contai[illegible] this may be

detected in the powder by the presence of long, strongly lignified fibers having a broad lumen.

Black Pepper (U. S. P. 1820 to 1926; N. F. 1926 to 1936) is the dried, full-
...Linné. The plant is a woody, perennial
various parts of India, and cultivated
...er tropical countries. The commercial
supplies come mostly from Batavia and Singapore. The latter furnishes the best grade of black pepper and, as it is fire-dried, it possesses a somewhat smoky odor and taste.

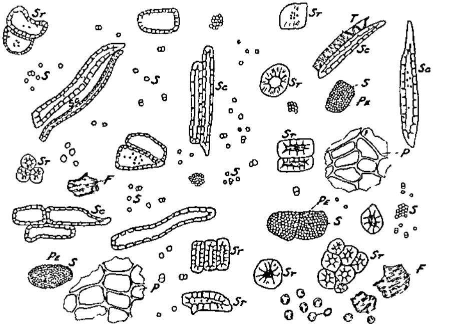

FIG 84.—Powdered Cubeb (*St*) stone cells, single or in isolated groups, nearly isodiametric, thick-walled, with numerous simple pores, and colorless or light yellow contents; (*T*) spiral tracheæ and sclerenchymatous fibers (*Sc*) few, the latter short, thick-walled, and strongly lignified, parenchymatous cells (*P* and *Pe*) with reddish brown tannin masses (*F*), oil-secretion cells with suberized walls, oil globules (*O*) numerous, starch grains (*S*) numerous, single or compound, the individual grains 2 to 12 microns in diameter. (Drawing by Hogstad.)

Black Pepper was known to Theophrastus and other ancient writers. It was introduced into Europe about the year 1000 and was the most important spice then known.

Pepper vines are trained on poles and trellises, the fruits being picked when the lowest ones on the rachis begin to turn red, and are dried in the sun or with artificial heat.

DESCRIPTION AND STRUCTURE.—See Figure 85.

Powdered black pepper is grayish brown, aromatic in odor, aromatic and pungent in taste, with numerous stone cells; much starch compacted into parenchyma cells; parenchyma fragments containing oil-secretion cells with suberized walls, cell
needle crystals
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The starch grains are angular or spheroidal and up to 6 microns in diameter.

Black pepper contains 1 to 2 per cent of volatile oil containing dipentene, phellandrene and a peculiar terpene; the alkaloid piperine, 4.5 to 8 per cent; piperidine, a colorless liquid alkaloid, which is a hydrolytic product of piperine; a pungent resin, chavicin; starch; tannin; about 10 per cent of proteins; and 5 per cent of ash.

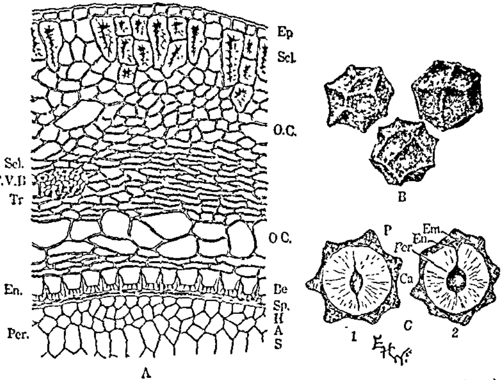


FIG. 85.—Black Pepper. *B*, commercial whole fruit 3.5 to 6 mm. in diameter, blackish brown and coarsely reticulate. *C*, lens view of sections of whole fruit; (*1*) transverse and (*2*) longitudinal. *P*, pericarp; *Per*, perisperm; *En*, endosperm; *Em*, embryo. *A*, transverse section of the pericarp. *Ep*, epidermis, *Scl*, sclerenchyma, *OC*, oil cells; *FVB*, fibrovascular bundle, *Tr*, tracheæ, *En*, endodermis of beaker cells; *Sp*, spermoderm; *Per*, perisperm, *H*, hyaline layer, *A*, aleurone layer, *S*, starch layer. (Drawings by E. H. Wirth.)

To demonstrate piperine, mount powdered black pepper in alcohol, cover with a cover-glass, and add a drop of water; long needles of piperine will readily separat … slowly, … piperin … of cadı …

… drochloric acid, not more than … r cent of stems or other foreign … tly in the pericarp, *while the* pungency is distributed throughout the seed; the more pungent and delicately aromatic peppers are preferred.

Piper is used as a condiment. It is a stimulant, an irritant, a tonic and a febrifuge. Average dose, 0.5 gm.

Black pepper in U. S. commerce has been extensively adulterated until the National Pure Food and Drugs Act became widely enforced. Since then such adulteration has gradually decreased to practically nil. Former adulterations included pepper hulls, representing the broken pericarp of the fruit obtained in the preparation of White Pepper; capsicum to increase pungency; starchy

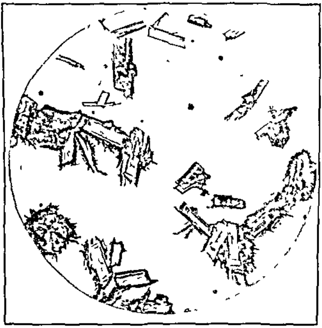


FIG. 86.—Piperine. (Photo by Adamson.)

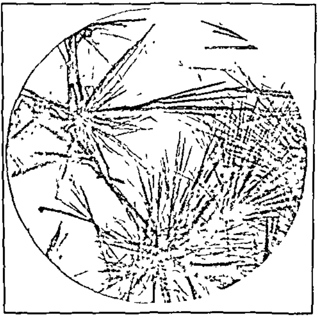


FIG. 87.—Piperine-cadmium compound. (Photo by Adamson.)

products; stone cell products, such as drupe pits, nut shells, etc.; woody products (sawdusts); and inorganic materials (chalk, gypsum, etc.).

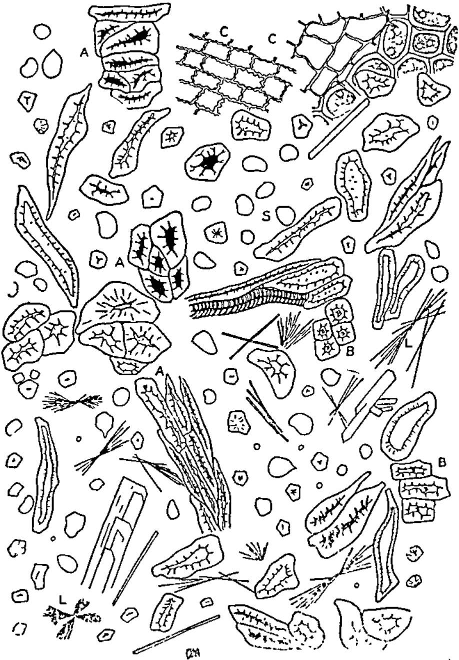


FIG. 88.—A mixture sold as ground black pepper but devoid of black pepper *A*, stone cells of olive endocarp, *S*, corn and wheat starch grains; *B*, stone cells of pepper hulls; *C*, fragments of seed coat and pericarp of cayenne pepper; *L*, crystals of calcium sulfate which separate on mounting the specimen in 25 per cent sulfuric acid.

Among the black pepper substitutes are: the fruit of *Embelia ribes* (Fam. [illegible]) a small tree of India, of [illegible] (Fam. *Lauraceæ*)

and *X. grandiflora*, *X. sericea* and *X. frutescens* of Brazil. *X. aromatica* yields

f *Piper nigrum* which have ripened and
icarp has been separated after the fruits
White pepper is globular and yellowish
gray in color. Removal of the outer pericarp exposes the fibrovascular bundles, about 15 in number, which appear as ridges on the outer surface extending from

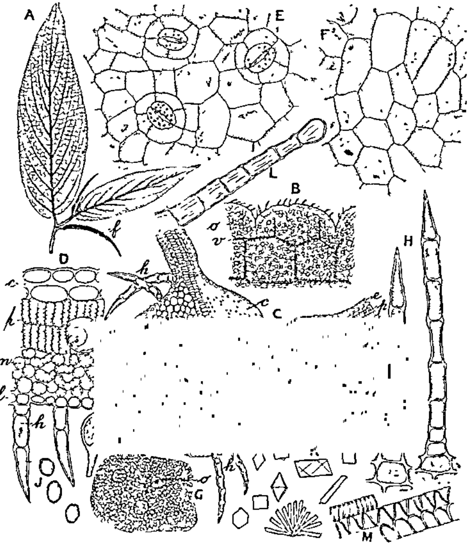
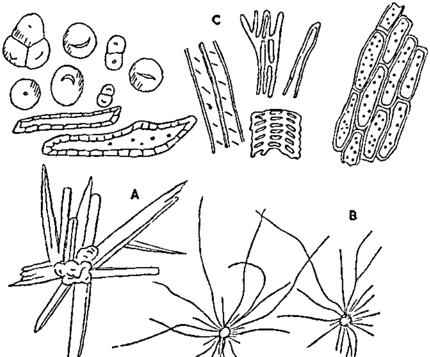


FIG 89 —Matico *A*, branch with leaves and flower spikes (*f*), *B*, section of leaf showing one of the truncate teeth, fibrovascular bundle (*v*), oil-secretion reservoirs (*o*), *C*,

perianth, *M*, tracheæ from the stem with spiral and annular markings.

base to apex. Ground white pepper is practically devoid of the larger isodiametric stone cells of the outer pericarp. It is less pungent and aromatic than black pepper, but due to its more delicate flavor is highly esteemed as a condiment.

Long Pepper (U. S. P. 1830, N. Y. ed.) is the fruit of *Piper longum*, a shrub *indigenous to the Malay Archipelago and consists of the entire spikes of the* immature fruit. The spikes are c[illegible]
thick, of dark grayish color, and [illegible]
black pepper. Oil cells in the s[illegible]
are absent, and the starch grains of the perisperm are from 2 to 10 microns in diameter. Long pepper yields about 4 per cent of piperine and about 1 per cent of a volatile oil with a pungent taste resembling that of oil of pepper, but with an odor resembling that of ginger.



[illegible] of sections or the powder
[illegible] length of
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Long pepper is also obtained from *Piper officinarum*, of Java, India and the Philippine Islands; *Piper sylvaticum*, of eastern India; *Chavica officinarum*, of the West Indies; and *Peperomia acuminata*, of Peru.

Matico (U. S. P. 1863 to 1916; N. F. 1916 to 1936) consists of the dried leaves of *Piper angustifolium*, a shrub indigenous to Peru and Bolivia. The specific name *angustifolium* means "narrow-leaf."

Matico usually occurs in large, compressed, matted masses; the leaves are short petiolate, oblong-lanceolate, 10 to 20 cm. long and 2 to 5 cm. broad (see Fig. 89).

Matico contains a volatile oil, the stearopten matico camphor, an acrid resin, a bitter principle and arthantic acid.

Matico is a stimulant and an antiseptic to the urinary tract. It is an astringent, a styptic, and vulnerary. Average dose, 4 gm.

Kava or Methysticum (N. F. 1916 to 1936) is the rhizome and roots of *Piper methysticum*, a plant indigenous to and cultivated in the South Sea Islands from Hawaii to the East Indies.

distinctly radiate xylem and occasionally a thin bark. A drop of sulfuric acid applied to the surface produces a deep cherry-red color. The odor of the drug is slight and the taste is sweetish and pungent, followed by a slight numbness. Pieces of the stem are more woody and have a hollow pith.

Kava contains about 5.3 per cent of resin, and the active constituents, methysticin, a derivative of piperic acid, and ω-methysticin. Methysticin may be identified by mounting powdered kava in alcohol, after partial evaporation of the solvent, prismatic needles appear at the edge of the cover-glass. The crystals polarize red-violet to yellow and dissolve with a purple color in H_2SO_4. Methysticin may also be obtained from kava powder by microsublimation, the result being much better if the powder is first treated with dilute H_2SO_4, emulsin or saliva.

Kava is a mild diuretic, an expectorant and a genito-urinary stimulant and antiseptic. Average dose, 1 gm

SALICACEÆ, OR WILLOW FAMILY

This family consists of two genera, viz.: *Salix* and *Populus*, with about 160 species of the former and 30 of the latter. The willows usually grow in wet ground and are extensively cultivated not only for ornamental purposes but for their economic uses, and occasionally for drying out damp ground, especially where the conditions are unsanitary. The twigs are used in the making of baskets, the wood furnishes a charcoal which is employed in medicine and in making crayons and gunpowder, and the bark yields salicin. The "pussy willow" (*Salix discolor*) is a small tree rather common in low meadows and river banks and is marked by thick cylindrical aments, the scales being copiously clothed with long glossy hair. The poplars are planted because of their rapid growth as shade trees, and to serve as windbreaks, especially in the western States. The wood is largely used in making paper, cardboard, etc. The balsam poplar or tacamahac (*Populus balsamifera*) and the balm of Gilead (*P. candicans*) are well-known trees of the United States, distinguished by their large resiniferous buds, used medicinally.

Salix or Willow Bark (U. S. P. 1820 to 1894) is the bark of *Salix alba*, a noble tree indigenous to Europe and naturalized in the northern United States and

The bark contains tannin, about 13 per cent; salicin, in variable amounts about as follows outer bark, 2 5 per cent; middle bark, 5 8 per cent; innermost layers, 11 3 per cent, bark collected in spring, 7.38 per cent, and that gathered in the fall, 6.66 per cent.

Willow bark is used as an astringent.

The bark of the black willow (*Salix nigra*) is used to some extent in this country. The tree is rather common in the United States, growing almost everywhere except in California. The bark of *Salix discolor* contains, in addition to salicin, the glucoside of metahydroxybenzaldehyde, salinigrin.

Poplar Bark (as a source of Salicin U. S. P. 1895 to 1936) is the bark of the white or silver poplar, also known as the great aspen or abele (*Populus alba*).

The drug consists of quills or flat pieces, varying in length and from 0.5 to 3 mm. in thickness; outer surface greenish white, smooth and with numerous lenticels; inner surface light brown and longitudinally striated; fracture short-fibrous; odor slight; taste bitter and astringent.

The bark contains, in addition to salicin, the glucoside populin or benzoylsalicin, which forms needle-shaped crystals, having a somewhat sweetish and acid taste and yielding upon hydrolysis saligenin (salicylic alcohol) and benzoic acid.

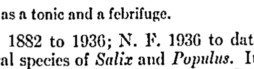
Poplar Bark is used as a tonic and a febrifuge.

Salicin (U. S. P. 1882 to 1936; N. F. 1936 to date) is a glucoside obtained from several species of *Salix* and *Populus*. It occurs in colorless shining needles or prisms melting at about 200° C. Salicin is soluble in water and alcohol but insoluble in chloroform and ether.

Most willow and poplar barks yield salicin, but the principal commercial source seems to be *Salix purpurea* and *Salix fragilis*, which are grown to a considerable extent in Belgium and are used for making baskets. They yield a thin reddish colored bark known as "rood schors." Salicin is usually obtained by macerating the bark in hot water for several hours; then filtering, concentrating in vacuum, treating with lime, and then with basic lead acetate to remove tannin. After removal of the excess lead the liquid is further concentrated until crystallization takes place The crystals are separated, redissolved, the solution filtered through animal charcoal and recrystallized.

PROPERTIES:

1. *Salicin is hydrolyzed into b-glucose and saligenin by emulsin.*



Salicin Saligenin

2. Saligenin may be oxidized ($K_2Cr_2O_7$ + H_2SO_4) into salicylic aldehyde having a characteristic odor.

3. Salicin ... After hydrolysis the saligenin for ... the free OH group ... hydrolysis the presence of glucose may be demonstrated by the reduction of the alkaline copper tartrate. Both these reactions serve to demonstrate the glucosidal properties of salicin.

4. Salicin gives a red color upon treatment with sulfuric acid which disappears upon the addition of water. This test has given some success in the localization of salicin in tissues. ... acid in the

USES AND ... It is a human syste... bitter tonic,

POPLAR BUD

Poplar Bud (N. F. 1916 to date) is the air-dried, closed, winter leaf-bud of *Populus candicans* Aiton, known in commerce as Balm of Gilead buds or of *Populus Tacamahacca* Miller (*Populus balsamifera* Linné), known in commerce as Balsam Poplar Buds. The trees yielding poplar bud are found in the northern United States and Canada. They occa-

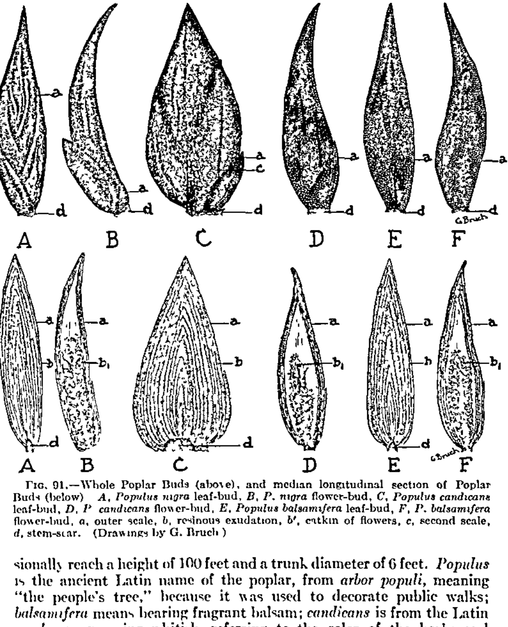


Fig. 91.—Whole Poplar Buds (above), and median longitudinal section of Poplar Buds (below) *A*, *Populus nigra* leaf-bud, *B*, *P. nigra* flower-bud, *C*, *Populus candicans* leaf-bud, *D*, *P candicans* flower-bud, *E*, *Populus balsamifera* leaf-bud, *F*, *P. balsamifera* flower-bud, *a*, outer scale, *b*, resinous exudation, *b′*, catkin of flowers, *c*, second scale, *d*, stem-scar. (Drawings by G. Bruch.)

sionally reach a height of 100 feet and a trunk diameter of 6 feet. *Populus* is the ancient Latin name of the poplar, from *arbor populi*, meaning "the people's tree," because it was used to decorate public walks; *balsamifera* means bearing fragrant balsam; *candicans* is from the Latin *candicare*, meaning whitish, referring to the color of the bark; and *Tacamahacca* is from the Spanish literally meaning "stinking pot tree." The leaf-buds are collected in the spring before they open. The buds of

the black poplar were known to Dioscorides and Theophrastus, but seem not to have been used internally as expectorants until toward the end of the nineteenth century.

Description and Structure.—See Figures 91, 92, 93, 94 and the National Formulary.

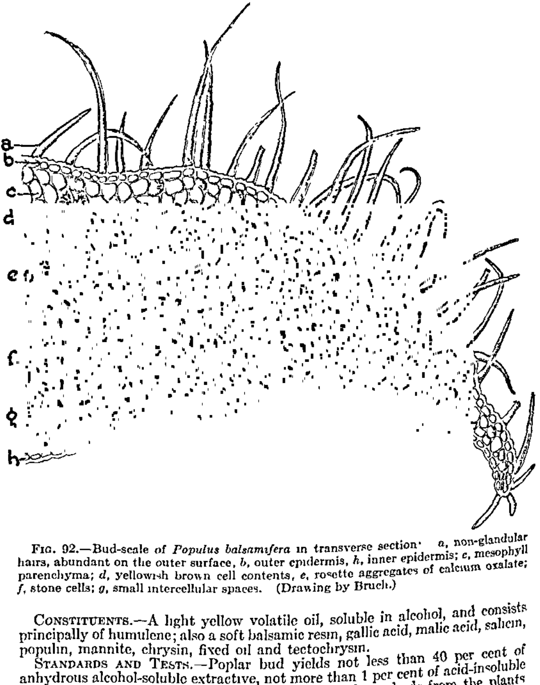


Fig. 92.—Bud-scale of *Populus balsamifera* in transverse section: *a*, non-glandular hairs, abundant on the outer surface, *b*, outer epidermis, *h*, inner epidermis; *c*, mesophyll parenchyma; *d*, yellowish brown cell contents, *e*, rosette aggregates of calcium oxalate; *f*, stone cells; *g*, small intercellular spaces. (Drawing by Bruch.)

Constituents.—A light yellow volatile oil, soluble in alcohol, and consists principally of humulene; also a soft balsamic resin, gallic acid, malic acid, salicin, populin, mannite, chrysin, fixed oil and tectochrysin.

Standards and Tests.—Poplar bud yields not less than 40 per cent of anhydrous alcohol-soluble extractive, not more than 1 per cent of acid-insoluble ash, and contains not more than 16 per cent of flower-buds from the plants yielding poplar bud.

Uses and Dose.—Poplar bud is employed as a stimulant and expectorant. Average dose, 4 gm.

Adulterants.—The buds of the fir (*Abies balsamea*, Fam. *Pinaceæ*) furnish an article known as **False Balm of Gilead Buds.** They are very aromatic and resinous and contain, besides tannin, a bitter glucoside, picein.

FIG. 93 —Bud-scale of *P. candicans* in transverse section *a*, non-glandular hairs, found at the margin only, *b*, outer epidermis, *h*, inner epidermis, *c*, mesophyll parenchyma, *d*, yellowish brown cell contents, *e*, calcium oxalate rosettes, *f*, stone cells, *g*, small intercellular spaces. (Drawing by Bruch)

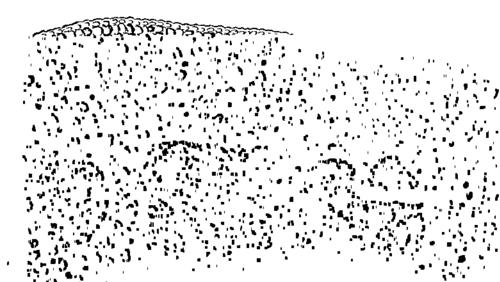


FIG. 94.—Bud-scale of *P. nigra* in transverse section non-glandular hairs wanting, *a*, outer epidermis, *g*, inner epidermis, *b*, mesophyll parenchyma cells, *c*, yellowish brown cell contents, *d*, rosette of calcium oxalate crystals; *e*, stone cells, *f*, intercellular space (Drawing by Bruch.)

Black Poplar (N. F. 1916 to 1936) consists of the buds of *Populus nigra*. They show fewer and shorter outer scales and exhibit no hairs. Buds of other *Populus* species are rarely found.

CHARCOAL

Activated Charcoal (U. S. P. 1936 to date) is the residue from the destructive distillation of various organic materials, treated to increase its adsorptive power.

It is a fine, black, odorless and tasteless powder, free from gritty matter. Activated charcoal should yield not more than 4 per cent of ash and not more than 3.5 per cent of acid-soluble substances. Carbonization must be complete as detected by the coloring of sodium hydroxide solution. It must be neutral to litmus and free from chlorides, sulfates, sulfides, cyanogen compounds and heavy metals, within the limits of the Pharmacopœia. The U. S. Pharmacopœia also makes standards for the adsorptive power of activated charcoal against strychnine sulfate, methylene blue and hydrogen sulfide. [illegible]

[illegible]

method consists of piling the chips of wood in a conical pile or stack, covering
this with earth and [illegible]
top; and igniting th[illegible]
closed; the newer [illegible]
air in cast iron retor[illegible]
coal made from will[illegible]
poses, wood charcoal must meet the requirements of activated charcoal.

Purified Animal Charcoal (U. S. P. 1842 to 1916; N. F. 1926 to date) is made by the destructive distillation of bone, and purified by boiling with hydrochloric acid. Its properties and standards are similar to those of activated charcoal.

MYRICACEÆ, OR SWEET GALE FAMILY

This is a family consisting of a single genus, of which the wax myrtle, or bayberry, *Myrica cerifera*, is the best known species.

Myrica, Bayberry Bark or Wax Myrtle Bark (N. F. 1916 to 1936) is the bark of the root of *Myrica cerifera*, a small shrub growing in sandy soil near the sea coast from New Jersey to Florida. It produces diminutive clusters of small wax-covered berries, and the wax, when melted off and mixed with tallow, is used to form candles. The bark is separated from the roots gathered late in the fall, cleaned and dried.

The bark occurs in strips or quills with a reddish brown outer surface and a dark brown, fine striate inner surface. The fracture is short and mealy; the odor distinct and aromatic; the taste slightly bitter and astringent, becoming pungent and acrid.

For structure see Figure 95.

The powdered drug is light reddish brown and sternutatory, with numerous single or compound starch grains up to 12 microns in length, and monoclinic prisms or rosette aggregates of calcium oxalate. Bast fibers, stone cells and crystal fibers with strongly lignified, porous walls are present; as also cork cells with thick, lignified or brownish walls and occasional woody fragments showing tracheæ with bordered pores.

Myrica contains a trace of volatile oil; two resins; myricinic acid; from 2.5 to 3.5 per cent of tannic acid; a trace of gallic acid, of sugar, and of mucilage.

Myrica is an astringent and a tonic. Average dose, 0.5 gm.

Allied Products.—The bark of the root of *Myrica carolinensis*, Northern ... The rhizome and leaves of the **Sweet Fern** ... the **Sweet Gale** (*Myrica gale*), are aro- ... medicine.

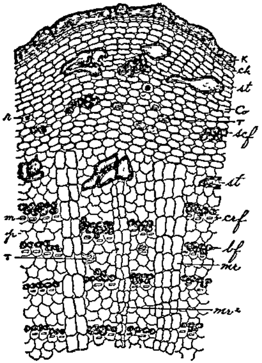


Fig. 95—Transverse section of root bark of *Myrica cerifera*, showing cork (*K*), cork cambium (*ck*), cortex (*Co*), tannin cells (*T*), stone cells (*st*), sclerenchyma fibers (*scf*), rosette crystals of calcium oxalate (*r*), monoclinic prisms of calcium oxalate (*m*), phloem (*p*), bast fibers (*bf*), primary medullary ray (*mr*), secondary medullary ray (*mr²*), and crystal fibers (*crf*). (After H. W. Youngken.)

JUGLANDACEÆ, OR WALNUT FAMILY

This is a small family of six genera, the most important of which are *Juglans* and *Hicoria*. These trees yield useful woods, the barks are used in tanning and dyeing, and the fruits are edible. *Hicoria pecan* bears the **pecan nut** found in the southern states, *H. ovata*, a large and handsome tree, known as shag-bark hickory, is the chief source of the **hickory nuts** of the market. There are six other common species of *Hicoria* which are indigenous to the United States and Canada, and all yield edible nuts.

The hulls (epicarp and mesocarp) of the English walnut, *Juglans regia*, have been used as an astringent, and the ground **nut shells** (endocarp) of this, as well as the other walnuts and hickory nuts, have been found as adulterants of spices.

Butternut Bark (U. S. P. 1820 to 1905; N. F. 1916 to 1936) is the inner bark of the root of *Juglans cinerea*, a tree growing in rich moist soil in the eastern

and central United States. *Juglans* is a contraction of "Jovis glans," meaning "nut of Jove;" *cinerea* means ash-colored; and "butternut" refers to the kernel, very rich in oil and of a butter-like flavor.

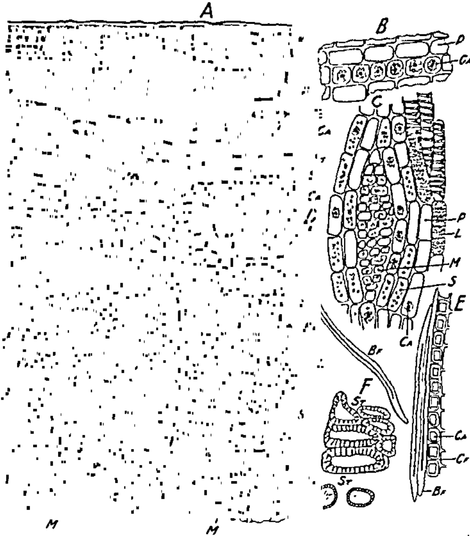


FIG. 96.—Juglans *A*, transverse section showing cork (*K*), parenchyma cells (*P*), parenchyma cells filled with tannin (*Tc*), rosette aggregates and monoclinic prisms of calcium oxalate (*Ca*), stone cells (*St*), sieve (*L*), bast fibers (*Bf*), starch grains (*S*); medullary rays (*M*). *B*, fragment showing parenchyma cells (*P*), and rosette aggregates of calcium oxalate (*Ca*) C, tangential section showing medullary rays (*M*), sieve (*L*) *D*, bast fiber in longitudinal view. *E*, fragment in longitudinal view showing 4-sided calcium oxalate crystals (*Ca*) in cells forming a crystal fiber (*Cf*) and adjoining 2 bast fibers. *F*, characteristic stone cells (*St*) (Drawing by Hogstad)

T[illegible], somewhat channeled pieces, of variable [illegible]cness, both the outer and inner surfaces [illegible]caly; fracture short, fibrous, the surface being somewhat checkered, odor distinct; taste bitter, astringent and acrid.

For the structure, see Figure 96.

The powdered drug is dark brown and exhibits calcium oxalate in rosette aggregates from 15 to 55 microns in diameter or in monoclinic prisms, from 10 to 50 microns in length, occurring in parenchyma or in crystal fibers; bast fibers, 30 microns wide and very long; stone cells, from 35 to 125 microns in

length; oily drops and purplish brown tannin masses in parenchyma; starch grains mostly single, or 2- to 4-compound, the individual grains from 3 to 15 microns in diameter, occasionally with a central cleft

Butternut bark contains about 7 per cent of a yellow, crystalline, acrid principle which is colored purple with alkalis; 2 to 2 5 per cent of a crystalline resin,

the crystal fibers with prismatic crystals are much more numerous.

BETULACEÆ, OR BIRCH FAMILY

This is a group of six genera of monœcious trees or shrubs. They are common to both hemispheres. The two genera of greatest importance are *Betula*, or birch, and *Corylus*, or hazelnut The birches are extremely hardy and some grow within the Arctic Circle. They find a great many uses.

Oil of Sweet Birch (*U. S P 1894 to 1916*) is a volatile oil, obtained by distillation with steam of the twigs and bark of *Betula lenta*, the sweet or black birch, a tree growing in the eastern and north central portions of the United States … is formed from the glucoside gaultheri… r to form methyl salicylate. This oil … **methyl salicylate** (U. S. P. 1894 to …

Birch … rch, *Betula alba*, is used to some extent in medicine as an astringent.

Rectified Birch Tar Oil, or Oleum Rusci (*N. F. 1916 to date*) *is the* pyroligneous oil obtained by the dry distillation of the bark and wood of *Betula pendula* Roth and related species of Betula, and rectified by steam distillation The principal commercial sources are Russia, Poland and Finland.

Properties.—The oil is a limpid, dark brown liquid with a penetrating empyreumatic odor resembling that of Russia leather It has a specific gravity between 0 886 and 0 950 and yields clear solutions with most solvents except methyl alcohol and water

Constituents —Creosote, cresol, guaiacol, and a trace of phenol.

Uses —Rectified oil of birch tar is used externally in lotions or ointments as a counter-irritant, a parasiticide and an antiseptic in various skin diseases.

FAGACEÆ, OR BEECH FAMILY

This is a family of monœcious trees or shrubs which are of a very wide geographic distribution. The three general representatives are the beech (*Fagus*), the oak (*Quercus*), and the chestnut (*Castanea*).

THE BEECH (FAGUS)

The beeches are among the most beautiful forest trees. The wood is not affected when immersed in water, hence it is largely used in the construction of dams, water-mills, etc.

Beech Nuts have a delicate flavor as human food and are used largely for fattening swine in the fall of the year.

Beechwood Tar or Wood Tar is usually obtained from the destructive distillation of the wood of the European Red Beech (*Fagus sylvatica*) or the Southern Beech (*F. americana*). The distillation, carried out in heated iron retorts, yields three layers of distillate; a light and a heavy layer with an intervening aqueous stratum. The aqueous layer, known as pyroligneous acid, contains about 6 per cent of acetic acid and 1 per cent or more of methyl alcohol. The heavy layer is wood tar.

Fig. 97.—White oak (*Quercus alba*). *A*, characteristic, lobed leaf, *B*, young branch

Methanol, Methyl Alcohol or Wood Alcohol (in reagents, U. S. P. 1894 to date, and N. F. 1926 to date) is obtained from the aqueous layer of the distillate from the destructive distillation of wood or synthetically from carbon monoxide and hydrogen. It is used very extensively as a solvent and for other industrial purposes.

Creosote, Wood Creosote or Beechwood Creosote (U. S. P. 1842 to 1942; N. F. 1942 to date) is a mixture of phenols obtained from wood tar. The wood tar, upon distillation, yields a distillate with a heavy layer, which is again distilled, after treatment with sodium carbonate, only

that portion of the distillate heavier than water being collected. This portion is purified with potassium hydroxide solution, sulfuric acid and redistillation until the potassium creosote solution does not turn brown upon being heated in air. The distillate boiling between 200° and 220° C. is retained.

Creosote is an almost colorless, or yellowish,

and fixed or volatile oils.
and hydrocarbons.

CONSTITUENTS.—Creosote is a mixture of phenol compounds among which are guaiacol and cresol

USES AND DOSE —Creosote is a stimulating expectorant Average dose, 0 25 cc.

Creosote Carbonate (U. S. P. 1916 to 1942; N. F. 1942 to date) is a mixture of the carbonates of the various constituents of creosote. It is used as an expectorant pulmonary antiseptic and is preferable to creosote because it is more easily borne by the stomach and the kidneys. Average dose, 1 gm.

Guaiacol (U. S. P. 1905 to 1942; N. F. 1942 to date) is methylcatechol, first isolated from guaiac resin in 1826; now prepared by the fractional distillation of beechwood creosote and subsequent purification.

Guaiacol Carbonate (U. S. P. 1916 to 1936; N F. 1936 to 1946) is a white, odorless, almost tasteless, crystalline powder, used mostly in veterinary practice as an intestinal antiseptic.

THE OAK (QUERCUS)

The oaks are among the most historic of our trees, and are noted for their strength, durability and longevity. Most species do not attain maturity before fifty or one hundred years, and some have attained an age of between five hundred and one thousand years. They furnish the most important woods of the world, the bark is used in tanning and dyeing and some species are used in medicine.

Acorns are largely used as a food for swine

Cork of commerce is the inner bark of *Quercus suber* or *Quercus occidentailis*, indigeno

White
bark of
States a
in the s

The bark is in flat, irregular pieces, 2 to 10 mm thick, yellowish brown, coarsely striate and with a coarse fibrous fracture. The taste is strongly astringent.
thick-
monoc
stone cells; and parenchyma with yellowish brown tannin masses.

The drug contains tannin, about 10 per cent, the ash yield is up to 6 per cent, the acid-insoluble ash about 0.3 per cent

White oak bark is used as an astringent and tonic Average dose, 1 gm.

Black Oak Bark or Quercitron Bark (U S P. 1820 to 1873) is the inner bark of *Quercus velutina* Lamarck. It contains the glucoside quercitrin, which yields the yellow coloring matter quercetin (see page 311).

Oxalic Acid (U. S. P. 1873 to 1882; as reagent, U. S. P. 1894 to date; N. F. 1936 to date) is present in many plants, usually occurring as the potassium or calcium salt and was first isolated in 1769. It was made by the fusion of woody or cellulose matter such as sawdust with sodium hydroxide, or by oxidation with nitric acid. It has but little use in medicine but extensive use as a reagent and industrially.

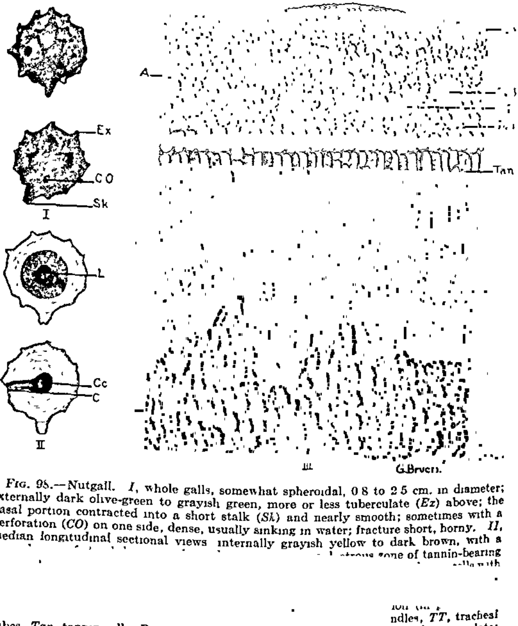


FIG. 98.—Nutgall. *I*, whole galls, somewhat spheroidal, 0 8 to 2 5 cm. in diameter; externally dark olive-green to grayish green, more or less tuberculate (*Ex*) above; the basal portion contracted into a short stalk (*Sk*) and nearly smooth; sometimes with a perforation (*CO*) on one side, dense, usually sinking in water; fracture short, horny. *II*, median longitudinal sectional views internally grayish yellow to dark brown, with a ... zone of tannin-bearing ... ndles, *TT*, tracheal tubes, *Tan*, tannin cells, *Ros*, rosettes of calcium oxalate; *Pr*, prisms of calcium oxalate; *Scl*, stone cells, *St*, starch, *Mar*, margin of cavity. (Drawings by Gerston Bruch)

Nutgall (U. S. P. 1820 to 1942; N. F. 1947 to date) is the excrescence obtained from the young twigs of *Quercus infectoria* Olivier and other allied species of *Quercus*. The galls are obtained principally from Aleppo, in Asiatic Turkey.

The excrescence (gall) is due to the puncture of a hymenopterous insect, *Cynips tinctoria*, and the presence of the deposited ovum; there are three stages in the development of the gall corresponding to the development of the insect:

1. When the larva begins to develop and the gall to enlarge, the cells of the outer and central zones contain numerous small starch grains
2. When the chrysalis stage is reached, the starch near the middle of the gall is replaced in part by gallic acid, but the peripheral and central cells contain masses of tannic acid.
3. As the winged insect is developed nearly all of the cells contain masses of tannic acid with a slight amount of adhering gallic acid.
4. After the insect has emerged from the gall, leaving a hole to the central cavity, the tannic acid, due to the presence of moisture and air, may be oxidized in part into an insoluble product, and the gall becomes more porous, constituting the so-called **White Gall** of commerce

The technical and medicinal use of galls was known to the ancient Greeks (450 B.C.). Ever since the Crusades, great quantities of them have been exported from Asia Minor.

Description, Histology and Powder.—See Figure 98 and the National Formulary.

Constituents —The principal constituent is tannic acid, which is found to the extent of 50 to 70 per cent, the drug also contains gallic acid, 2 to 4 per cent; ellagic acid, starch and resin Total ash 1 4 to 2.45 per cent; acid-insoluble ash about 0.1 per cent

Standards and Tests.—An aqueous mixture of powdered nutgall (1 in 10,000) gives a dark blue precipitate with 5 per cent ferric sulfate solution, a dark brown precipitate with 1 per cent ferric acetate solution, an orange-brown color and a slight precipitate with saturated potassium dichromate plus a trace of acetic acid; and a yellowish brown color and a slight precipitate with 1 per cent sodium carbonate solution

Uses and Dose —Nutgall is the source of tannic acid and is used in the tanning and dyeing industry and in the manufacture of ink Medicinally it is us[illegible]

[illegible] *mica*
an [illegible]
pl[illegible]
le[illegible]
acid. They [illegible]
more or less [illegible]
wall is abou[illegible]
insects in the form of a grayish powder.

American nutgalls are formed on *Quercus coccinea* and *Q. imbricaria* by *Cynips aciculata.* When fresh they are globu[illegible]
of a yellowish, somewhat mottled color On [illegible]
[illegible] about 5 cm. in diameter and

TANNINS

Tannins comprise a large group of substances which are widely distributed in plants; in fact practically every group of plants contains

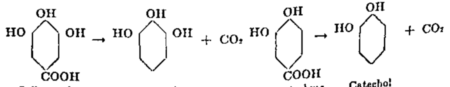
species which bear tannin to some extent. In plants that contain large amounts of tannin it is usually localized in specific plant parts. Being probably an end product of metabolism it is often found in dead tissue such as in the outer bark, in heartwood, in galls, etc. Tannins are also found in immature fruits but disappear upon the ripening of the fruit. It has been suggested by some that the fruit employs the energy supplied by the oxidation of these tannins in its metabolic processes, and by others that the tannins are the source of the fruit acids. One theory states that the tannins are "plant antiseptics" and as such prevent damage by fungi and insects. While these theories are somewhat speculative it appears to be apparent that, regardless of their purpose in plants, tannins are the end products of metabolism.

Tannins are non-crystalline substances which form colloidal solutions with water, these ... astringent taste; they precipi... soluble com... lead and tin ... acid); they ... with potassium ferricyanide and ammonia and in alkaline solutions many of their derivatives readily absorb oxygen.

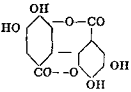
This property of precipitating proteins is the basis of the employment of tannins as astringents. In the treatment of burns, for example, the proteins of the exposed tissues are precipitated forming a mildly antiseptic, protective ... This property ... is respon-

... type produces the "tanner's red" The deeply colored compounds obtained with iron salts have been utilized in the manufacture of ink, and because of their precipitation reactions, solutions of tannin are utilized in the laboratory as reagents for gelatin, proteins, alkaloids, etc.

Chemically tannins are complex substances They usually occur as mixtures the separation of which is very difficult. Thus any chemical means of proving their constitution is almost hopeless. The tannin of greatest interest is gallotannin from nutgall. Fisher and Freudenberg believe gallotannin to be pentadigalloyl glucose, a condensation product of 1 molecule of glucose with 5 of ... of Mitchell and Schmidt indicates ... glucose may be present in ... bove, that it is an integral ... nature ... the majority probably are not W... decompose into relatively simple polyhydric ... protocatechuic acid, which acid, which decomposes ... tannins decomposes into catecho... colora- are responsible for their ... tion with iron salts



Gallic acid — Pyrogallol — Protocatechuic acid — Catechol



Ellagic acid

The classification of tannins is usually based upon the colors obtained with iron salts. It has definitely been demonstrated that in the presence of catechol
obtained with ferric iron
phenolic groups a blue
ypes may be present in
the same plant extract, the one present in larger amount will mask the one present in lesser amount Then too, tannins of the ellagic acid type, which contain pyrogallol nuclei will produce a green coloration because of the two free phenolic groups. The usual classification of tannins is as follows

1. **Phlobatannins** (also known as catechol or pyrocatechol tannins), which yield catechol upon heating; when boiled with HCl they yield red insoluble phlobaphenes; with $FeCl_3$ they form a green color, and with bromine water a precipitate
2. **Pyrog** ... boiled with HCl they ... color; and with brom ... in found in ... and pomegranate bark)
... leather but yield colors with iron salts.

Tannic Acid, Gallotannic Acid, or Tannin (U S P. 1842 to date; as reagent, U. S. P. 1882 to date, N F 1936 to date) is a tannin usually obtained from nutgall. The powdered galls are extracted with a mixture of ether, alcohol and water; the liquid separates into two layers, the aqueous layer containing gallitannin and the ethereal layer the free gallic acid present in the gall After separation the solution of gallitannin is evaporated, the tannin being purified in various ways. Acetone and other solvents are sometimes used and it is said that a considerable amount of commercial tannin comes from Chinese and Japanese galls.

Description and Tests —Amorphous powder, glistening scales or spongy masses, light brown to yellowish white, odor faint, taste strongly astringent Tannic acid is soluble in water, alcohol and acetone, and insoluble in ether, chloroform and benzin An aqueous solution of tannic acid is colored bluish black with ferric
from solution. T
drying at 100° C
free from gum, dextrin, and resinous substances

Uses and Dose —Tannic acid is used in the treatment of burns, and as an
... to 1942) is a product
se, 0 6 gm
l of albumin (usually egg albumin) and tannic acid. Average dose, 2 gm

Gallic Acid (U. S. P. 1851 to 1926; N. F. 1936 to 1947, as reagent, U. S. P. 1926 to date) is 3:4:5 trihydroxybenzoic acid, crystallizing with one molecule of water. It occurs in nutgall or may be prepared from tannic acid by hydrolysis with dilute acids (see page 214).

Gallic
slightly
form. I
it yields
pure ferrous salts and should be free from tannic acid.

Gallic acid is a mild astringent. Average dose, 1 gm.

Pyrogallol, or Pyrogallic Acid (U. S. P. 1894 to 1942; N. F. 1942 to date; as reagent, U. S. P. 1916 to date) is 1:2:3, trihydroxybenzene, and is obtained by heating gallic acid (see page 214).

Description and Tests.—White leaflets or fine needles, soluble in water, alcohol, and ether. Melting-point, 130° to 133° C. Pyrogallol in solution is rapidly oxidized by the air, especially in the presence of alkalis. Pyrogallol in a 1 in 10 solution reduces salts of silver, gold and mercury.

Uses.—Pyrogallol is used externally as an irritant and antiseptic in skin affections.

THE CHESTNUT (CASTANEA)

The chestnuts constitute very useful and ornamental trees. There are three well-known species, namely: *Castanea sativa* or European Chestnut; *C. dentata* or American Chestnut; and *C. crenata* or Japanese Chestnut.

The **nuts** are an important article of food in many nations, used toasted or boiled for humans and raw by swine and other animals. The large Spanish nuts are extensively exported.

The **timber** is much like that of oak, but finer grained. It is used as a finishing lumber. **Chestnut Extract**, a tanning material, is prepared from the wood and bark and contains 26 to 30 per cent of tannin, and is used especially for sole leather.

An **extract** of the leaves is used as a mild astringent in medicine.

A fungus disease attacks the bark of the chestnut in Asia, but the Japanese trees are sufficiently resistant as not to be killed. This fungus was introduced into the United States and it has nearly destroyed the American chestnut forests. Resistant strains have been developed and are now being planted in
[illegible] tates, from Maine to Michigan and south to

[illegible] to 1905; N. F 1916 to 1947) consist of the dried leaves of *Castanea dentata* (Marshall) Borkhausen. The leaves are gathered at the time of flowering of the tree or shortly afterward and are carefully dried.

Description, Structure and Powder.—See Figure 99 and the National

[illegible] tannic acid, colored green with ferric
[illegible] of tartar emetic; also mucilage which
is insoluble in alcohol. It is used as a tonic and an astringent. Average dose, 4 gm.

Chinquapin Bark (U. S. P. 1820 to 1851) is the dried bark of *Castanea pumila* Michaux. This bark, like that of the chestnut, contains tannin and has been used as an astringent. The seeds are smaller than chestnuts but contain about 45 per cent of starch and 2.5 per cent of protein.

ULMACEÆ, OR ELM FAMILY

This family consists mostly of shrubs and trees growing in the tropics and in temperate regions. Many of the plants of this family have dis-

tinct mucilage cells. In *Ulmus* they are very prominent in the form of short, broad cylindrical cells, regularly arranged in the squares formed by the tangential rows of bast crossing the medullary rays, giving the transverse section a checkered appearance.

Fig. 99.—C[illegible] midrib showing upper [illegible]

ELM

Elm; Elm Bark, or Slippery Elm (U. S. P. 1820 to 1936, N. F. 1936 to date) is the dried inner bark of *Ulmus fulva* Michaux, a tree indigenous to the eastern and central United States and Canada. The generic name *Ulmus* is the classic name of the elm, *fulva* means "yellow" or

"tawny," and is applied because the bark is of this color. The bark is collected in spring, deprived of the periderm and dried, the commercial article coming chiefly from Michigan.

DESCRIPTION.—In flat, oblong pieces 1 to 4 mm. thick; outer surface weak yellowish orange, longitudinally wrinkled and furrowed and with occasional dark brown patches of periderm; inner surface usually finely striated longitudinally; fracture fibrous, porous from large mucilage cells.

STRUCTURE.—See Figure 100.

POWDER.—Weak yellowish orange in color; odor distinctive, suggesting fenugreek; taste mucilaginous. Bast fibers are numerous, very long, up to 25 microns in diameter, thick-walled, unlignified, or but slightly so; calcium oxalate in monoclinic prisms, mostly in crystal fibers, the individual crystals

contains starch and calcium oxalate. Total ash from 7.45 to 9.92 per cent; acid-insoluble ash up to 0 62 per cent.

FIG. 100 ... bast fibers ... of associated ... stal sieve, and ... fied cells frequently elongated and the crystals super-imposed so as to form short ... crystal fibers, c, medullary rays 2 to 6 cells wide, bearing starch, and forming in transverse sectional view distinct squares with the tangential plates of leptome. (Drawing by E. N. Gathercoal.)

STANDARDS.—Good elm bark yields a rather thick mucilage when 1 part of the ground bark is digested in 40 parts of cold water for one hour.

USES AND DOSE.—Ulmus is a demulcent and an emollient. Average dose, *ad libitum*.

ADULTERANTS AND ALLIED PRODUCTS.—Ground elm bark has been reported to be adulterated with wheat starch or wheat middlings. It may also be adulterated with a bark from which ... with barks poor in mucilage. *Ulmus campe*... ...ark which is dark brown, and contains, besid... tannin.

MORACEÆ, OR MULBERRY FAMILY

These are herbs, shrubs or trees, distinguished for the most part by having laticiferous cells, which occur in both the axis and leaves of the mature plant. The laticiferous tubes in the pith often extend through the medullary rays, uniting with those in the cortex. In the leaves of some species of *Ficus*, the laticiferous tubes are found associated with vascular bundles only, while in other species, as the common rubber plant in cultivation (*Ficus elastica*), the tubes send out branches which traverse the mesophyll tissue. *Ficus elastica* yields **Assam rubber**, while *Castilla elastica* yields **Central American rubber.** Cystoliths and long bast fibers commonly occur in the family.

Cannabis, Indian Hemp, American Hemp (U S P. 1873 to 1942) consists of the dried flowering tops of the pistillate plants of *Cannabis sativa* Linné, an extract of Indian hemp was recognized in the U S P. of 1862, though the drug itself was not recognized.

The plant is an annual herb indigenous to central and western Asia, and is cultivated in India and other tropical and temperate regions for the fiber and seed *Cannabis* is the ancient Greek name for hemp

Cannabis was used in China and India, spreading slowly through Persia to the Arabs, and it probably was introduced into European and American materia medica about the time of Napoleon.

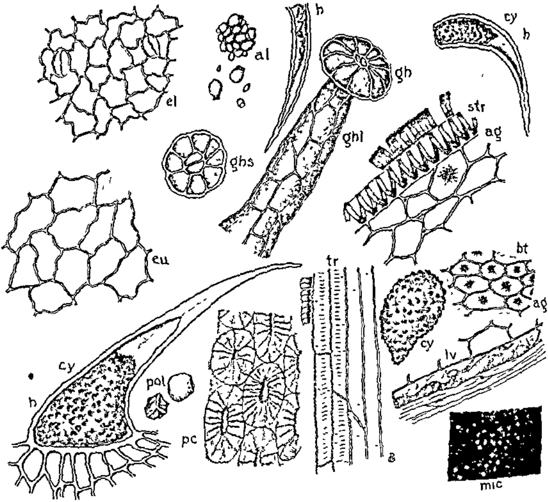
The amount of resin found in the pistillate flowering tops of *Cannabis sativa* markedly decreases as the plants are grown in the more temperate climates Thus Indian cannabis yields 20 per cent or more of resin, Mexican cannabis 15 per cent or less, Kentucky hemp 8 per cent or less, Wisconsin hemp 6 per cent or less. The active principles are found in the resin in about the same, or even smaller, ratio as that indicated above The hemp leaves contain a small amount of the resin.

Indian cannabis is prepared rather carefully from the pistillate flowerheads only, with relatively few leaves, but Mexican and American cannabis consist of the whole upper portion of the stalk of the pistillate plant Indian cannabis may have an activity about ten times as great as that of a poor quality of American cannabis.

The [illegible]
graph i [illegible]
because [illegible]
tion of [illegible] American cannabis was
[illegible] d in
[illegible] can-
[illegible] ipths
[illegible] sons
[illegible]
[illegible] wing
[illegible] ver,
[illegible] dian
cannabis, along with the marihuana campaign, has cost the materia medica a valuable drug, for the medicinal use of cannabis in the United States has been discontinued.

For the description of the whole drug and characteristics of the powdered drug, see Figure 101 and the U. S Pharmacopœia, 11th revision.

Indian cannabis *contains 15 to 20* per cent of a resin, cannabin; *cannabinol* (cannabindon), a red, oily *substance* said to possess the intoxicating *properties* of the drug; a yellowish volatile oil; a volatile alkaloid, cannabinine; *ash from*



slender pointed apex *and* an enlarged base, usually containing a cystolith (*cy*) but fre- quently broken and the *cystolith* freed, glandular hairs of two kinds, one with a short ... stalk (*ghl*), the head (*gh*) in ... ents of bracts and leaves ... sette aggregates (*ag*) of ... d (*str*) or reticulate (*tr*) ...

tracheæ, and phloem, (... yellowish brown, finely ... globules and aleurone g ... crystalloids and globoid ... ing a rosette aggregate ... Paul D. Carpenter.)

... the latter ... The ... lative,

an analgesic *and* a narcotic. Average dose, 100 mg.

ALLIED PRODUCTS.—An **African Cannabis** has been imported which, while not of as good appearance as the East Indian drug, yielded 14.06 per cent of a resin having full *therapeutic activity*. A **Turkish cannabis** has been imported which yielded 9 per cent of resin, having the average therapeutic activity of the standard drug. Physiologically active cannabis also comes from Turkestan, Asia Minor, *France*, *Italy*, Spain and Mexico, and from the warmer and more arid regions in the United States.

Cannabis is cultivated to a considerable extent for its bast fibers, **hemp**, and fruits, **hempseed**; the latter contain about 20 per cent of a fixed oil which is used *for culinary* purposes and in the manufacture of paints and soap, the cake meal being used as cattle food.

Humulus or Hops (U. S. P. 1890 to 1926, N. F. 1926 to 1947) is the dried
dular hairs The plant is a
, Asia and North America,
and various parts of the
it is also naturalized.
re ripe, carefully dried by
bags They are sometimes
id to prevent change of the
active principles.

The strobiles are ovoid-cylindrical, up to 3 cm. long and 2 cm. wide with a sharply undulate rachis and about 50 membranous bracts, color pale yellow green; odor strongly aromatic and characteristic, taste aromatic and bitter. The *numerous*, orange colored glandular trichomes at the base of the bracts are the important characteristic of the powder. The bracts and rachis of humulus contain *tannin* but the glandular hairs give the principal activity to the drug

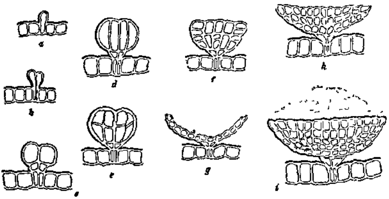


FIG 102 —Lupulin: *a*—*h*, successive stages in the development of the glandular hairs

The loss
of -like odor
an rug. It is
a s
glandular
trichomes rcial
the
The
has been carefully dried and preserved.

Lupulin is a bright, yellowish orange, granular powder consisting of trichomes with a somewhat globular, multicellular head 100 to 300 microns in diameter,

with a single layer of secreting cells arranged in the form of a shallow cup, from the inner surface of which the cuticle has been separated by the secreted oleoresin; odor aromatic, characteristic of hops; taste aromatic and bitter. In

resin and wax. Total ash, about 11 per cent with about 2.5 per cent of acid-insoluble ash in which can be seen, under the microscope, the remains of the silicified cell walls of the drug.

Lupulin yields not less than 60 per cent of non-volatile ether-soluble extract and not more than
reddish brown color

USES AND DOSE.—
dose, 0 5 gm.

Ficus or Fig (U. S. P. 1820 to 1916; N. F. 1916 to 1936) is the partially dried fruit of *Ficus carica*, a tree indigenous to Persia and cultivated in most subtropical and tropical countries. The fig contains 50 to 60 per cent of glucose and is eaten as a nutrient, demulcent and laxative.

mo
tre

mo

When figs are dried, roasted and ground, th
as **Fig Coffee**, which is also used sometimes
detected by the large, thin-walled and broad
epidermis, the broad latex tubes, 30 to 50
achenes. The latter somewhat resemble the achenes of strawberry fruits, but are distinguished by the reticulated thickening of the outer cell wall.

URTICACEÆ, OR NETTLE FAMILY

Urtica or Stinging Nettle is the flowering plant of *Urtica urens* and *Urtica*

principle and possibly also an alkaloid.

Urtica is a powerful diuretic. Average dose, 45 cc. of the decoction.

SANTALACEÆ, OR SANDALWOOD FAMILY

Most of the members of this family are shrubs or trees indigenous to the tropics. A few are found growing in the United States, as the Oil-nut or Buffalo-nut (*Pyrularia pubera*), the fleshy fruit of which is edible and the seeds of which contain an acrid fixed oil. Others are parasitic on the roots of other plants. There are 26 genera with about 250 species.

) 1947) is the heartwood of *Santalum album*
India. It attains a height of 10 meters and
It is extensively cultivated in southeastern

Asia and the Sandalwood Islands of the Indian Archipelago, the present supply coming largely from southern India. The heartwood from twenty to forty-year old trees is cut into billets, the most select wood being retained in India for distillation of the oil, and the wood of the smaller stems or branches exported through Bombay to China, Europe and the United States

Sandalwood contains 1.5 to 6 per cent of volatile oil The wood is used in ... the volatile oil to which it owes

... ps of varying shapes and sizes, heavy, hard, but splitting easily, color light yellowish brown with alternating lighter and darker concentric zones nearly equal in width Odor characteristic, aromatic, persistent; taste peculiar, strongly aromatic

It displays many very narrow medullary rays from one to four cells wide, the cells thick-walled and radially marked, tracheæ large, numerous, usually solitary, with bordered pores, wood fibers numerous, with pointed ends and ...

Santal Oil, Sandalwood Oil (U. S. P 1882 to 1942, N. F 1942 to date) is the volatile oil distilled with steam from the dried heartwood of *Santalum album* Linné.

Description —A pale yellow, somewhat viscid, oily liquid having the odor and taste of sandalwood. The oil contains about 95 per cent of a mixture of sesquiterpene alcohols known as santalol and consisting of α-santalol (B P 300° C) and β-santalol (B. P. 170° C) as well as small quantities of esters, ketones and other alcohols and aldehydes

Standards —Santal Oil yields not less than 90 per cent of alcohols calculated as santalol ($C_{15}H_{24}O$ ... yield not less than 2 per ...

Uses and Dose.—Oil of Santal is a ... to some extent an expectorant in bronchitis Average dose, 0 5 cc. It is also employed ...

Allied ... Sandalwood Oil is obtained by the distillation of ... and is used in India and China as a substitute ... ns sesquiterpene alcohols known as "fusanols," ... cent, but the oil may be rectified to yield this ... Oil is obtained from *Amyris balsamifera* ... is derived from *Santalum* ... similar to that of roses. **East African Sandalwood Oil** is obtained from ... *tenuifolia* and has an odor resembling that of West Indian Sandalwood Oil. **Fiji Sandalwood Oil** is obtained from *Santalum yasi*.

ARISTOLOCHIACEÆ, OR BIRTHWORT FAMILY

These are herbs or twining woody plants with reniform or cordate, palmi-nerved leaves. There are about 200 species, mostly represented in tropical and subtropical countries, of which about 180 belong to the genus *Aristolochia*. The family is especially characterized by the presence of secretory cells containing a volatile oil Tannin-containing cells are also present in certain of the *Aristolochiæ*. Cells with silicified walls are found in the upper epidermis of the leaf and the palisade tissue. A non-glandular hair, the terminal cell of which is curved like a hook, is rather characteristic in *Aristolochia* and other genera.

SERPENTARIA

Serpentaria (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the dried rhizome and roots of *Aristolochia serpentaria* Linné, known in commerce as **Virginia Snakeroot,** or of *Aristolochia reticulata* Nuttall (U. S. P. 1851 to 1942; N. F. 1942 to date), known in commerce as **Texas Snakeroot.**

Virginia snakeroot is found growing from New England to Florida and west to Michigan and Missouri. Texas or Red River Snakeroot is collected in the woods of Texas, Louisiana, Arkansas and Oklahoma. The generic name *Aristolochia* means "an aid in childbirth," although the drug probably does not possess any value for this purpose; *serpentaria* refers to the twining of the vine in a snake-like fashion; and *reticulata* to the network of veins in the leaves. The rhizome and roots are collected in autumn and dried.

Description and Structure.—See Figures 103 and 104 and the National Formulary.

Powder.—Pale brown to dusky yellow, odor camphoraceous or terebinthin- ... to 4-compound, ... 3 to 18 microns ... ents numerous, consisting of tracheæ, wood fibers, medullary ray cells and pith cells; a few typical non-glandular hairs of the stem are occasionally present.

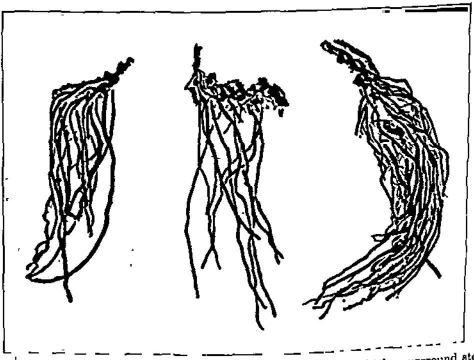


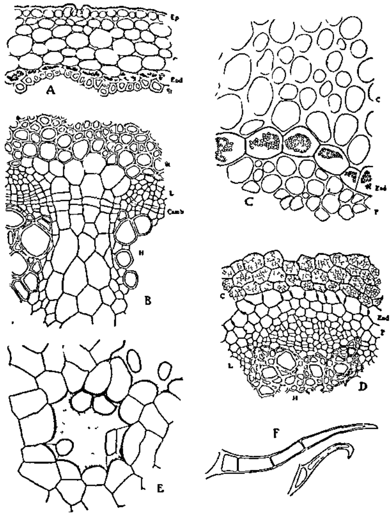
Fig. 103.—Serpentaria. The dried rhizome and roots, with a little overground stem projecting at the top of *Aristolochia serpentaria*, which constitutes the official drug. (Photo by Paul D. Carpenter.)

Constituents.—Volatile oil 0.5 to 2 per cent, the important constituent of which is borneol; a bitter poisonous principle, aristolochin, also known as

serpentarin and an alkaloidal principle, aristolochine; several organic acids,
c ash about 2.75 per cent in

an 10 per cent of its over-
foreign organic matter, and
yields not more than 10 per cent of acid-insoluble ash.

USES AND DOSE.—Serpentaria is an aromatic, bitter stimulant and a tonic. Average dose, 1 gm.



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chyma (c) of which the entire cortex is made up, starch-bearing endodermis (*End*) and pericycle (*P*) which is very much reduced. *D*, transverse section of a secondary root showing starch-bearing parenchyma cells of cortex (*C*), endodermis (*End*) of thin-walled cells with distinct Casparyan spots and free from starch; pericambium (*P*); phloem (*L*); wood (*H*). *E*, epidermis with silicified cells from the upper or ventral surface of the lamina of the leaf which are the cause of the small perforations seen in the leaf blade when held toward the light. *F*, non-glandular hairs from the leaf, one of which is very prominently curved, forming a small hook. (After Holm.)

SUBSTITUTES.—The rhizome of Yellow Root (*Jeffersonia diphylla*, Fam. *Berberidaceæ*) is sometimes substituted for serpentaria, from which it is distinguished by its lack of odor and by having a bitter, acrid taste.

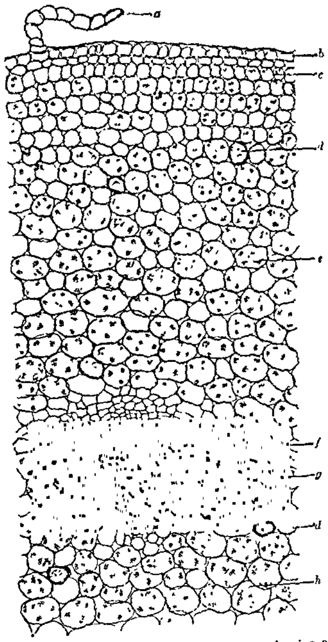

Fig. 105.—Asarum. Transverse section of the rhizome showing a uniseriate non- ... (e) starch-

Asarum, Wild Ginger, or Canada Snakeroot (*U. S. P. 1820 to 1873; N. F. 1916 to 1947*) is the dried rhizome and roots of *Asarum canadense* Linné. The plant is an acaulescent, perennial herb growing in rich woods of the northern and central United States and southern Canada.

The rhizome is gathered in the spring, usually deprived of the roots and

carefully cleaned and then dried, most of the supplies coming from North Carolina, Virginia, Indiana and Michigan.

Asarum rhizome is horizontal, 2 to 4 mm. thick, occasionally branched,

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frequentl
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gum; a f
6 5 to 9

Asarum is an aromatic stimulant, a carminative and a tonic. Two antibiotic substances have recently been isolated from Asarum, one of which is very active against Gram-positive pus-forming bacteria. Average dose, 2 gm.

ALLIED PLANTS.—The rhizome of a related species, *Asarum europæum*, a common plant of the mountainous regions of Europe, is used in the countries in which it grows. It very closely resembles that of *Asarum canadense* and is of a grayish or reddish brown color, with an aromatic and pungent taste, and the powder is sternutatory. It contains 1 per cent of a volatile oil which consists in part of a camphor known as asarin or asaron, tannic acid, colored green with ferric salts, starch; and resin.

POLYGONACEÆ, OR BUCKWHEAT FAMILY

Most of the members of this family are herbaceous plants, with nearly entire leaves, and distinguished by having jointed stems, sheathing united stipules, and a 3- to 4-angled achene. The plants frequently contain tannin cells and resinous secretory cells, the latter sometimes branched. The hairs include both non-glandular and glandular, the head in the latter usually being small, but sometimes large and peltate. Calcium oxalate occurs in the form of rosette aggregates.

RHUBARB

Rhubarb (U. S. P. 1820 to date) consists of the dried rhizome and roots of *Rheum officinale* Baillon or of *Rheum palmatum* Linné or of other species (excepting *Rheum Rhaponticum*) or hybrids of *Rheum*, grown in China or Tibet and deprived of the periderm tissues. *Rheum* comes from the Latin *Rha*, the name of the Volga River near which a species of *Rheum* grows, *palmatum* is in reference to the large, spreading leaves.

The rhizomes are collected in autumn from plants that are eight to ten years old; peeled, perforated, strung on ropes, and dried either in the sun or by artificial heat. The drug is exported chiefly from Shanghai. The principal commercial varieties are known as Chinese rhubarb, Canton rhubarb and Shensi rhubarb, the last-named being preferred.

Rhubarb was known in China as early as 2700 B.C. The *Rha* of the ancient Greeks was possibly Rhapontic rhubarb from near the Black Sea. The Chinese drug may have reached Europe as early as the first

FIG. 106.—*Rheum palmatum* growing in the Medicinal Plant Garden, University of Minnesota.

FIG. 107.—*Rheum officinale* growing in the Medicinal Plant Garden, University of Minnesota.

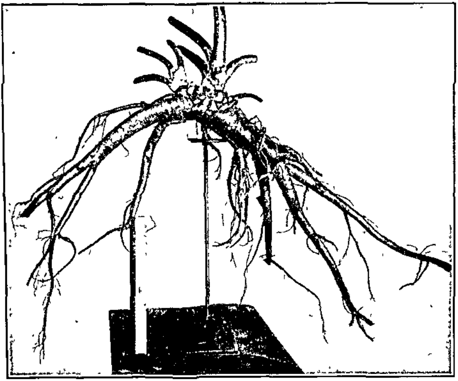

FIG. 108.—*Rheum palmatum* root system, showing typical heavy roots without distinct rhizomes. Medicinal Plant Garden, University of Minnesota.

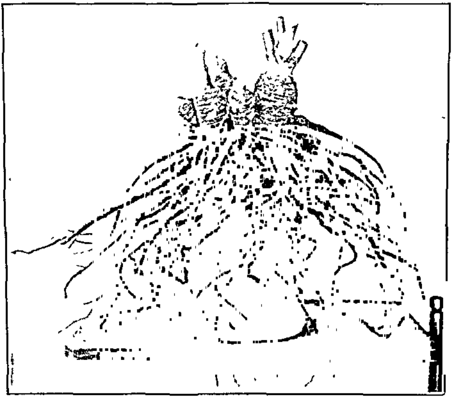

FIG. 109.—*Rheum officinale* root system, showing large distinctive rhizomes and relatively small roots. Medicinal Plant Garden, University of Minnesota.

century A.D. Russia maintained a practical monopoly from about 1650 to near 1800 A.D. by bringing in high quality drug overland from China. Then the drug, frequently of inferior quality, largely came into Europe by sea routes.

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 106, 107, 108, 109, 110, 111 and the U. S. Pharmacopœia.

CONSTITUENTS.—The principal co

7 per cent of calcium oxalate; up to 15 per cent total ash; and about 0.2 per cent acid-insoluble ash.

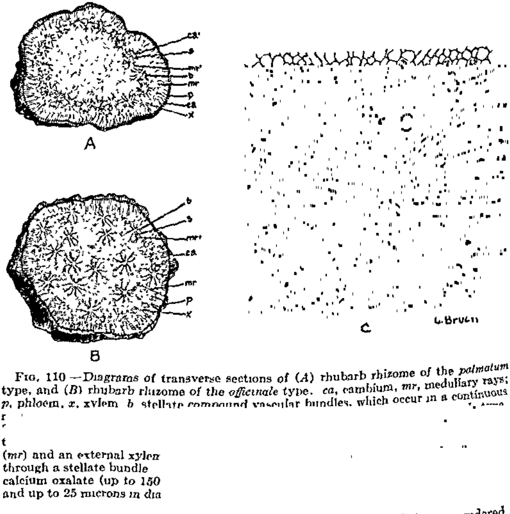

FIG. 110.—Diagrams of transverse sections of (A) rhubarb rhizome of the *palmatum* type, and (B) rhubarb rhizome of the *officinale* type. *ca*, cambium, *mr*, medullary rays; *p*, phloem, *x*, xylem *b*, stellate compound vascular bundles, which occur in a continuous

(*mr*) and an external xylem through a stellate bundle calcium oxalate (up to 150 and up to 25 microns in dia

The anthraquinone compounds may readily be separated from powdered rhubarb by microsublimation (see Figs. 112 and 113).

If low heat is employed the sublimate consists of small needles and prisms, frequently in X-arrangement or rosette formation. Higher temperatures gener-

ms.

to the sublimate the latter dissolves with

STANDARDS AND TESTS.—Rhubarb that is light in color, buoyant, or spongy in texture should be rejected. Rhubarb yields not less than 30 per cent of diluted alcohol extractive and not more than 2 per cent of acid-insoluble ash. Rhubarb responds to tests for emodin and chrysophanic acid.

USES AND DOSE.—Rhubarb is a laxative, a purgative, a stomachic, an astringent and a tonic. Average dose, 1 gm.

Compound Rhubarb Powder or **Gregory's Powder** (U. S. P. 1863 to 1936; N. F. 1936 to date) contains powdered rhubarb 25 parts, magnesium oxide 65 parts, and powdered ginger 10 parts, by weight.

DESCRIPTION.—A pinkish mobile powder, becoming darker on exposure to air; the powder contains finely granular magnesium oxide, numerous starch grains and characteristic fragments of vegetable tissues; ginger starch grains are ellipsoidal or ovoid, frequently with a prominent beak, from 5 to 60 microns in diameter, rhubarb starch is in single or compound, spheroidal or polygonal grains, often with a central cleft and up to 25 microns in diameter; mounts [illegible] e clearly the fragments [illegible] of rhubarb, in some of [illegible] ıte crystals of calcium [illegible] of the alkalis many of the fragments become deep red in color.

USES AND DOSE.—Compound Rhubarb Powder is used as an antacid and laxative. Average dose, 2 gm

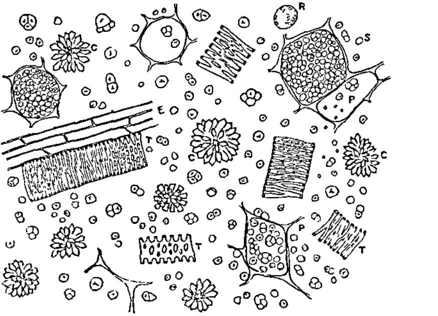

FIG. 111.—Powdered Rhubarb *C*, rosette aggregates of calcium oxalate, up to 150 microns in diameter, *P*, parenchyma containing starch grains (*S*), from 4 to 25 microns in diameter; *T*, tracheæ, *E*, sieve, *R*, reddish brown amorphous masses separated from the resin or tannin cells

ADULTERANTS —Coarse wheat flour, colored with curcurma, has been found in powdered rhubarb, as has also the exhausted drug (the dried marc after preparation of the fluidextract). The latter can be detected by the reduced yield of extractive.

The rhizomes of other species of *Rheum* are also substituted to a limited

similar to those of rhapontic rhubarb.

Rhapontic Rhubarb consists of the peeled rhizomes of *Rheum Rhaponticum*. Tl liate. the crystalline glucoside rh r rhein. Rhaponticin is colored purplish red, changing to orange, with sulfuric acid. It is insoluble in ether and readily separates from a dilute alcoholic fluidextract on the addition of ether.

Powdered rhapontic rhubarb responds to the following tests: (1) Boil 10 gm. of the powder for fifteen minutes with 50 cc. of diluted alcohol under a reflux condenser, filter, concentrate to 10 cc., cool, shake with 15 cc. of ether and set the mixture aside for twenty-four hours: crystals of rhaponticin will separate. (2) Shake 0.5 gm. of the powder with 5 cc. of a 2 per cent ammonia solution, keep the mixture at about 30° C. for fifteen minutes, filter into a watch-glass and set aside crystals of rhaponticin will separate. (3) Examine the powder in filtered ultra-violet light: a marked fluorescence is noted. Official rhubarb responds to none of these tests. A mixture of not less than 25 per cent of rhapontic rhubarb in official rhubarb can be detected by these tests.

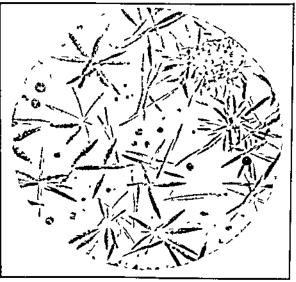

FIG 112 — Photomicrograph of sublimate from rhubarb at low temperatures.

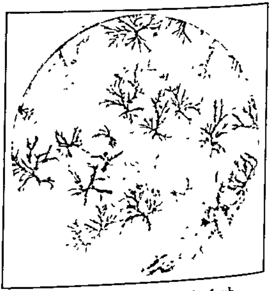

FIG 113 — Photomicrograph of sublimate from rhubarb at somewhat higher temperature.

Rumex, Yellow Dock, or Curled Dock is the root of *Rumex crispus* or *Rumex obtusifolius* **Rumex Obtusifolius** and **Rumex Brittanica** were each U. S. P. 1820 to 1863, and then were superseded by **Rumex** U. S. P. 1863 to 1905; N. F. 1916 to 1936.

The drug is collected in the autumn, freed from adhering rootlets, cut into longitudinal pieces c dried.

The root is nearly cm. in diameter; externally reddish brown or g ly annulate above, deeply wrinkled longitudinally; fracture short and dusty, somewhat fibrous; odor slight; taste astringent and somewhat bitter.

The cortex is thick and consists, along with the central cylinder, of starch-bearing parenchyma; cork of several layers of thin-walled cells and, in *R. crispus*,

a few lignified cells beneath the cork; cambium distinct; vascular bundles with few scattered tracheæ and very few fibers

the wall; and light brown cork cells.

Rumicin, isomeric with chrysophanic acid; nepodin, in greenish prisms, and lapodin, in small needle-shaped crystals may be the active constituents. Total ash about 5 1 per cent with about 0.4 per cent of acid-insoluble ash.

Rumex is an alterative, a laxative

Bistorta or English Serpentary is

tall perennial herb growing in Europ

20 per cent of gallic acid and yields about 5 5 per cent of total ash and 0 4 per cent of acid-insoluble ash. It is used as a tonic and an astringent. Average dose, 2 gm.

CHENOPODIACEÆ, OR GOOSEFOOT FAMILY

The plants are annual or perennial herbs and are widely distributed. The leaves are mostly alternate and without stipules; the flowers are usually small and of a green color; and the fruit is a 1-seeded utricle. The most prominent characteristic in the structure is the anomalous development of the stem, in which secondary cambiums arise, producing additional vascular bundles at the periphery of those originally formed. A great variety of non-glandular hairs occur. Glandular hairs are rare except in a few genera as *Atriplex* and *Chenopodium,* where occur bladder-like hairs for the storing of water The beet, *Beta vulgaris,* and spinach, *Spinacia oleracea,* are important economic plants belonging to this family.

CHENOPODIUM

Chenopodium, or American Wormseed (U. S P. 1820 to 1905) is the fruit of *Chenopodium ambrosioides* var. *anthelminticum* (Linné) Asa Gray

Chenopodium Oil or Oil of American Wormseed (U. S P. 1820 to 1947, N. F 1947 to date) is the volatile oil distilled with steam from the fresh, flowering and fruiting, overground parts of *Chenopodium ambrosioides* var. *anthelminticum* (Linné) Asa Gray The plant is indigenous to the West Indies but naturalized in the United States. It is extensively cultivated in Carrol County, Maryland, the oil distilled from plants in that locality being known as Baltimore Oil. If the plants are grown for the fruits they are allowed to mature, but when grown for the oil they are harvested while the tops are still green and immediately distilled. The oil is formed in glandular hairs (see Fig. 115), occurring on the leaves, flowers and fruits, but being particularly abundant on the pericarp and ovary The yield of oil is from 1 to 2 per cent of the partially dried herb.

and 1.4790 at 20° C., and is soluble in not less than 8 volumes of 70 per cent alcohol.

CONSTITUENTS.—Ascaridol, 60 to 80 per cent; *p*-cymene about 20 per cent; *l*-limonene and *d*-camphor. *Ascaridol, the active principle, is an organic peroxide, liable to explode when heated.*

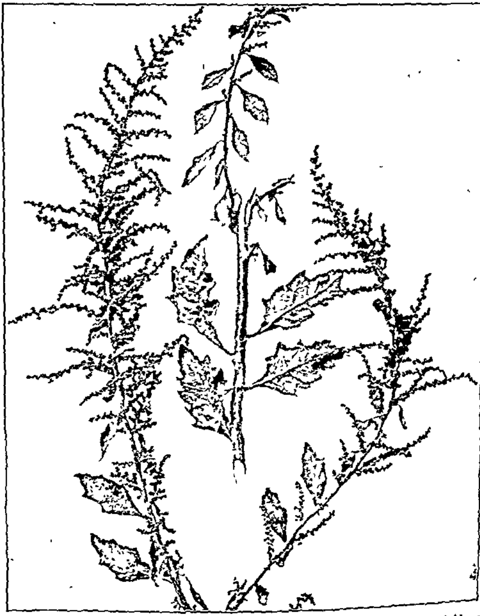

FIG. 114.—American Wormseed. Fruiting branches of *Chenopodium ambrosioides* var *anthelminticum* (From U. S. Department of Agriculture.)

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resembling and very closely related to *Chenopodium ambrosioides* var. *anthelminticum*, and widely distributed in the United States It yields about 0.3 per cent of a volatile oil which is used in Brazil as an anthelmintic.

FIG. 115.—Photomicrograph of a single pistil of *Chenopodium* just previous to pollination showing the numerous glandular hairs which in the normal state form a dense ring-like cluster on the upper half of the ovary. These hairs become detached in the mechanical preparation of the mount. (Photo by Hogstad)

PHYTOLACCACEÆ, OR POKEWEED FAMILY

The family includes herbs, shrubs and trees and comprises less than 100 species. They are for the most part indigenous to tropical and subtropical America and Africa, being represented in the United States by one genus, *Phytolacca*. The structure of the root is anomalous, consisting of the formation of successive secondary rings of vascular bundles. The hairs are of the simple, uniseriate type. Neither glandular hairs nor special secretory cells occur in plants of this family.

Phytolacca, or Poke Root (U. S P. 1820 to 1916, N. F. 1916 to 1947) is the

Phytolacca root externally is yellow-brown, thickly annulate with light-colored, low, transverse ridges. Internally it is very light brown
slices characterized by alternating zones of
parenchyma, formed by secondary cambiu
drug is light yellow to brownish; sternutatc
compound grains, the individual grains up

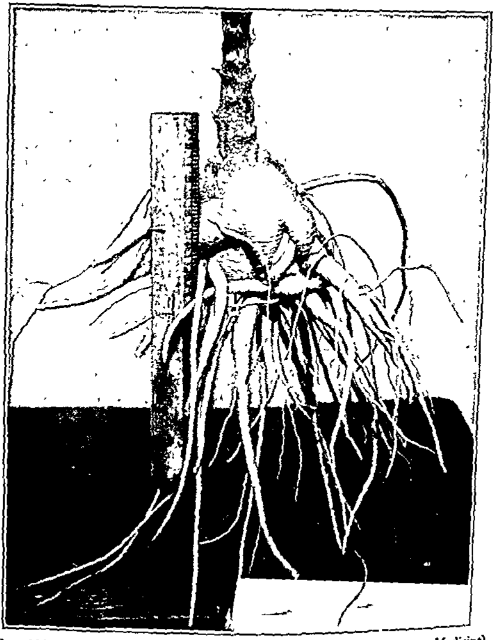

FIG. 116.—*Phytolacca americana*. Root system of one-year-old plant. Medicinal Plant Garden, University of Minnesota.

oxalate is in sphenoidal microcrystals or raphides up to 50 microns in length; long sclerenchymatous fibers associated with large scalariform tracheæ are numerous.

Phytolacca Fruit or Poke Berries (U. S. P. *1820 to 1905*) *occur in agglutinated* masses of a purplish black color, and consist of the compound berries, which are about 8 mm. in diameter and composed of 10 loculi, each of which contains

a single, lenticular, black seed. The sarcocarp is fleshy, sweet and slightly acrid, and contains a purplish red coloring principle which is soluble in water but not in alcohol, and which is decomposed on heating the aqueous solution.

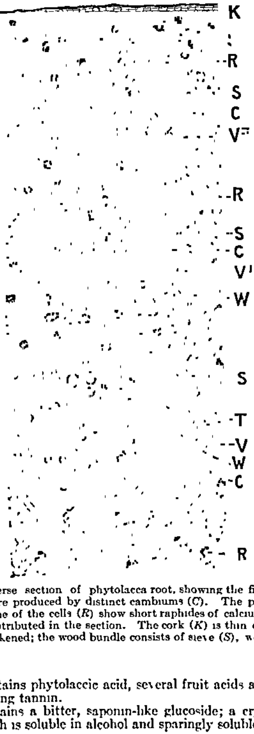

FIG. 117.—Transverse section of phytolacca root, showing the fibrovascular bundles (V, VI, VII) which are produced by distinct cambiums (C). The parenchyma contains little starch, and some of the cells (R) show short raphides of calcium oxalate, many of the crystals being distributed in the section. The cork (K) is thin except at the ridges, where it is much thickened; the wood bundle consists of sieve (S), wood fibers (W) and tracheæ (T).

The fruit also contains phytolaccic acid, several fruit acids and phytolaccin, a substance resembling tannin.

Phytolacca contains a bitter, saponin-like glucoside; a crystalline alkaloid, phytolaccine, which is soluble in alcohol and sparingly soluble in water, phyto-

laccic acid; formic acid; potassium formate; total ash about 8.5 per cent, of which about one-half is potassium oxide; acid-insoluble ash about 0.5 per cent.

Phytolacca is an alterative, an emetic and a purgative. *Average dose: emetic,* 1 gm.; *alterative,* 0.1 gm.

RANUNCULACEÆ, OR CROWFOOT FAMILY

This is a large family, consisting of about 1200 species, widely distributed except in the tropics. They are mostly annual or perennial herbs, a few being somewhat woody and climbing, as *Clematis*. The parts of the flower are numerous, the sepals and petals being from 3 to 15, the stamens indefinite, and the carpels usually 5 to 20. The fruits are either achenes, follicles or berries. In transverse sections the xylem of the collateral vascular bundle is heart-shaped, having the phloem distributed in the sinus. The pericycle, especially in the woody species, is in the form of a closed ring of sclerenchyma. The hairs are both glandular and non-glandular, the former being always 1-celled and usually mucilaginous. In the leaves of *Aconitum* and *Anemone*, so-called "arm cells" occur in the palisade layer.

ACONITE

Aconite or Monkshood (U. S. P. 1851 to 1942; N.F. 1942 to date) is the dried tuberous root of *Aconitum napellus* Linné. *Aconitum* is from the Greek, meaning "without soil" and refers to the plant growing on stony ground; *napellus* is from the Latin, meaning "little turnip" and refers to the shape of the root.

The plant is a perennial herb with a fusiform tuberous root from which arise one or more lateral shoots which develop into conical daughter tubers. The plant may be propagated from the daughter tubers. There are about 60 species of *Aconitum* which differ widely from one another in constituents and which readily hybridize; hence only the official species should be propagated for drug. The drug is preferably gathered at the flowering stage, though in the fall the aconitine content also appears to be high; the flower offers the best means for differentiating species. The drug is collected in Germany and Switzerland from wild plants, and in England from cultivated plants, and carefully dried. The poisonous nature of *Aconitum* was known to the ancient Chinese and Indians. Of the eighteen varieties of aconite mentioned by Hindu writers, ten were considered too poisonous to be used in medicine. Its poisonous nature was well known in mediæval times, but Störch, a Viennese physician, introduced it into medicine in 1762.

Description, Structure and Powder.—See Figures 118, 119, and the National Formulary.

Constituents.—Aconitine, a crystalline alkaloid, up to 0.75 per cent, it readily hydrolizes into benzoylaconine and aconine, both of which are amorphous. Aconine is much less toxic than, and apparently produces physiological effects contrary to those of aconitine. The hydrolysis of aconitine may be expressed by the following equations.

$$\underset{\text{Aconitine}}{C_{34}H_{47}O_{11}N} + H_2O \rightarrow \underset{\text{Benzoylaconine}}{C_{32}H_{45}O_{10}N} + \underset{\text{Acetic acid}}{CH_3COOH}$$

$$\underset{\text{Benzoylaconine}}{C_{32}H_{45}O_{10}N} + H_2O \rightarrow \underset{\text{Aconine}}{C_{25}H_{41}O_9N} + \underset{\text{Benzoic acid}}{C_6H_5COOH}$$

Amorphous aconitine (mild aconitine) consists of a mixture of alkaloids or decomposition products from aconite. It is about one-tenth as toxic as crystalline aconitine

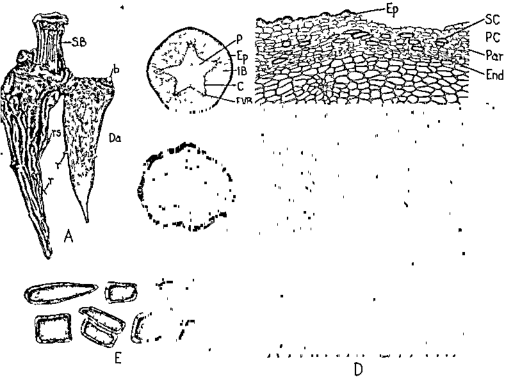

FIG 118 —*Aconitum napellus* *A*, tuberous root (*T*) with attached daughter tuber (*Da*) (these are conical, smooth or longitudinally wrinkled, externally dark brown or grayish brown, from 4 to 10 cm in length and from 1 to 3 cm in diameter at the crown), showing stem-base (*sb*), bud (*b*), root-scars (*rs*), or short rootlets (*r*) *B*, lens view of a transverse section of a young tuberous root, *C*, lens view of a transverse section of an older tuberous root, and *D*, more highly magnified view of the transverse section of the tuberous root Epidermis (*Ep*), primary cortex (*pc*) consisting of parenchyma (*Par*) with scattered characteristic stone cells (*sc*); modified endodermis (*End*), inner bark

100 to 400 microns in length (Drawing by Bernard Marder)

Aconitine (U. S. P. 1851 to 1882, 1905 to 1936; as a reference standard, U. S. P. 1936 to 1942; N. F. 1936 to date) is an alkaloid obtained from aconite.

It appears as colorless or white crystals, odorless and stable in air. It is extremely poisonous and should not be tasted. It melts at 197° to 198° C, after preheating to 180° C, it is slightly soluble in water and readily soluble in alcohol, ether or benzene An aqueous solution of the alkaloid, after acidulating with acetic acid, gives on the addition of a solution of potassium permanganate, a red crystalline precipitate, phosphomolybdic acid, potassium mercuric iodide

'or reaction;
ntain toxic
ine of high

STANDARDS.—Aconite possesses a potency, per cubic centimeter of tincture, quivalent to not less than 0.15 mg. of reference aconitine.

An unofficial qualitative test having some quantitative value in determining he potency of powdered aconite is as follows: 0.5 gm. of the finely powdered conite is mixed with 500 cc. of water and shaken occasionally during the ourse of five minutes. A few cubic centimeters of the filtered solution, if swalowed, produces a distinct and characteristic sensation in the throat.

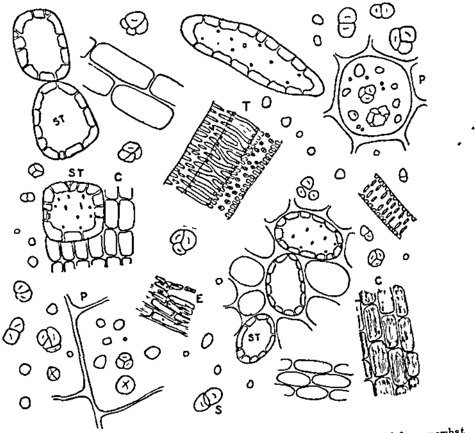

FIG. 119.—Powdered Aconite. Starch grains (*S*) numerous, spheroidal, somewhat plano-convex, single or 2- to 5-compound, the individual grains from 3 to 20 microns in diameter and frequently with a central cleft, tracheæ (*T*) mostly with slit-like, simple pores, sometimes with spiral or reticulate thickenings or with bordered pores; stone cells ... 400 microns in (*St*) sing ... mple length, ... (*P*) pores, f ... long, numerous, the cells being filled with starch grains, bast fibers from stems ... or oblique, with lignified walls about 5 microns in thickness, and marked by transverse or oblique, slit-like pores.

USES AND DOSE.—Aconite is a heart and nerve sedative; locally in the form of a tincture, it is used as an analgesic. Average dose, 0.06 gm.

Aconite Leaves (U. S. P. 1820 to 1882) consists of the leaves and flowering tops of *Aconitum napellus*. The drug should be protected against air and light after gathering and careful drying

It occurs more or less crumpled or broken; entire leaves long petiolate, and palmately divided into 3 to 7 segments; each with 2 or 3 deeply incised lobes which are linear and acutely pointed. The flowers are dark blue, usually in a spike-like raceme, the upper sepal being hooded or helmet-shaped and covering the 2 long-clawed smaller petals; fruit of 2 or 3 separate somewhat flattened lanceolate follicles and enclosing several seeds.

The powder is dark yellowish green; ...
walled epidermal cells and elliptical sto
colored purplish red upon the addition
upon the addition of solutions of the alkalis

The drug contains aconitine from 0.15 to 0.3 per cent; aconitic acid, tannic acid, inosite and sugar; ash yield from 15 to 20 per cent Aconite leaves have the same, though weaker, actions as aconite root

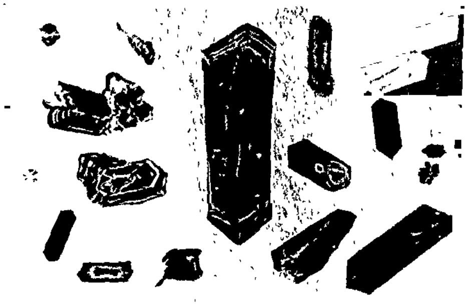

Fig. 120 —Aconitine orthorhombic crystals, crystallized from alcoholic solutions.

Allied Drugs —**Japanese Aconites.**—Two aconites appear in commerce under this designation, one derived from *Aconitum fischeri* having a conical root smaller and less wrinkled than the official drug, and the other derived from *Aconitum uncinatum* var. *japonicum*, which is shorter and plumper than the official drug. The former contains japaconitine, which upon hydrolysis yields acetic and benzoic acids and japaconine, the latter contains jesaconitine which upon hydrolysis yields acetic and anisic acids and jesaconine

Indian Aconites.—Several aconites native to India are occasionally found in commerce, the most common from *Aconitum ferox*, *Aconitum balfourii*, *Aconitum laciniatum* and *Aconitum deinorhizum* The roots of these species are considerably larger (up to 15 cm in length and 4 cm in diameter at the crown) and the starch is more or less gelatinized from excessive heating during drying. The roots contain pseudoaconitine which, upon hydrolysis, yields acetic and veratric acids and pseudoaconine Other Indian varieties include *Aconitum chasmanthum*, a very small root (up to 2 cm long) containing indaconitine which upon hydrolysis yields acetic and benzoic acids and pseudoaconine, *Aconitum spicatum* containing bikhaconitine which yields acetic and veratric acids and bikhaconine; and *Aconitum heterophyllum* containing the alkaloid atisine which is much less toxic than the aconitines. **Other Aconites** include *Aconitum stærckianum*, a native of the Alps, the conical roots of which often occur in clusters of three or four, and contain aconitine *Aconitum lycoctonum* is a yellow-flowered European species having a several-headed rhizome and contains lycaconitine.

HYDRASTIS

Hydrastis or Golden Seal (U. S. P. 1831 to 1842, 1863 to 1936; N. F. 1936 to date) consists of the dried rhizome and roots of *Hydrastis canadensis* Linné.

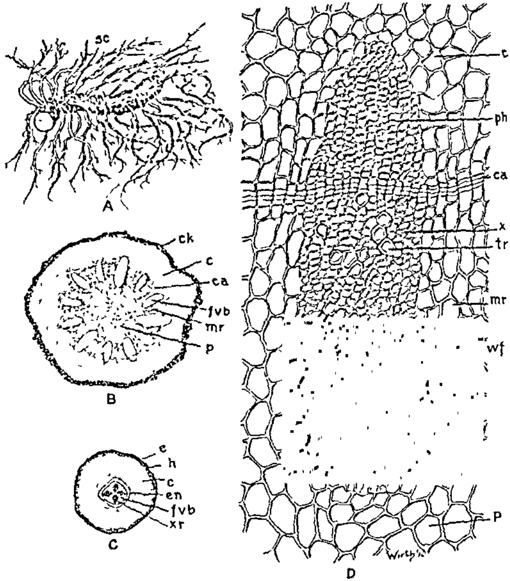

FIG. 121.—Hydrastis *A*, entire drug consisting of a horizontal flexuous, subcylindrical *rhizome*, 1 to 5 cm long and 2 to 10 mm in diameter more or less annulate and wrinkled ... and longitudinally, yello... ep numerous roots or sl... n. yellow or grayish yel... rt in diameter more or... of ... ns view of a tran...), endodermis (*en*) and a central ... transverse section through one of the fibrovascular bundles of the rhizome showing cortex (*c*), phloem (*ph*), cambium (*ca*), xylem (*x*) with tracheæ (*tr*) and wood fibers (*wf*), medullary ray (*mr*), and pith (*p*). (Drawings by Wirth.)

Hydrastis is from the Greek meaning "to accomplish or act with water;" the specific name refers to the habitat. The plant is a perennial herb with a short horizontal rhizome bearing numerous long, slender roots. Golden seal was plentiful in the forests of the eastern United States and Canada, but in recent years has become almost extinct, due to ruthless collection because of its relatively high market price. It is still collected from wild plants to some extent in the Ohio River Valley, and is cultivated in Oregon, Washington, North Carolina, Tennessee, Michigan, Wisconsin and other localities. The plants, propagated from rhizome buds, require from three to four years to produce marketable drug. It is gathered in autumn, the terminal buds replanted and the drug carefully dried. Hydrastis was known to the Cherokee Indians, who used it as a dye as well as an internal remedy, and who introduced its use to the early American settlers.

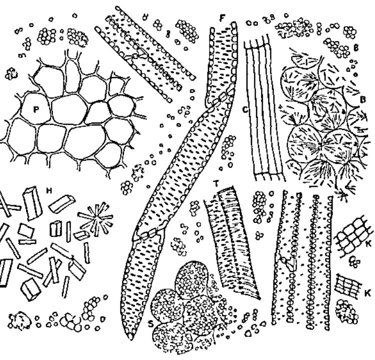

FIG 122.—Powdered Hydrastis *P*, parenchyma; *S*, parenchyma containing numerous

acid to a powder previously moistened with water.

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 121, 122, and the National Formulary.

CONSTITUENTS.—Three alkaloids have been isolated from hydrastis; hydrastine, berberine and canadine; of these, hydrastine (1.5 to 4 per cent) is the most important.

Hydrastine (U. S. P. *1905 to 1926*) is readily soluble in chloroform, alcohol and ether, but almost insoluble in water. It crystallizes in prisms, melting at 131° to 132° C. On treatment
oxidation yielding opianic acid
the *Pharmacopœia* as **Hydras**
which occurs in light yellow needles or powder, very soluble in water or alcohol, but much less so in chloroform or ether.

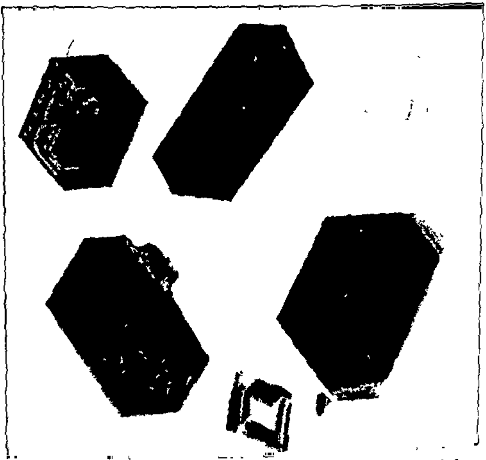

FIG. 123.—Hydrastine large, nearly equidimensional orthorhombic crystals from alcoholic solution.

Hydrastine Hydrochloride (U. S. P. 1916 to 1926; N. F. 1926 to date) occurs as a white or creamy white powder, odorless, bitter and hydroscopic. It is readily soluble in water or alcohol, but slightly so in chloroform or ether.

Berberine is readily soluble in water but almost insoluble in ether. The salts of berberine form bright yellow crystals. Berberine sulfate crystallizes in needles melting at 144° C

l-**Canadine** is insoluble in water but readily soluble in alcohol, chloroform and ether. It crystallizes in needles melting at 134° C.

These alkaloids may be obtained by microsublimation or by *microextraction* and *may* be identified by means of microcrystalline reactions. *Mounting the* ... crystals of the *alka-* ... ntity test for hydrastis

STANDARDS.—Hydrastis yields not less than 2.5 per cent of the anhydrous ether-soluble alkaloids of hydrastis. It contains not more than 4 per cent of foreign organic matter, and yields not more than 3 per cent of acid-insoluble ash.

USES AND DOSE.—Hydrastis is a bitter tonic and an astringent used in inflammation of the mucous membrane. Hydrastine and Hydrastinine salts are internal hemostatics. Berberine salts are antiperiodic, stomachic, and tonic. *l*-Canadine paralyzes the central nervous system and causes severe peristalsis. Average dose, of the drug, 2 gm., of hydrastine, 100 mg.; of hydrastinine hydrochloride, 0.3 gm.; of berberine sulfate as stomachic and tonic, 45 mg., as antiperiodic, 0.6 gm.

FIG. 124.—Berberine sulfate orthorhombic crystals from aqueous solution.

ALLIED PLANTS.—The alkaloid berberine, or a principle closely resembling it, is found in the following plants of the *Ranunculaceæ*, False rhubarb (*Thalictrum flavum*) of Europe; and the following plants growing in the United States: gold-thread (*Coptis trifolia*), yellow root (*Zanthorhiza apiifolia*), and marsh marigold (*Caltha palustris*). A principle resembling berberine is found in the following plants belonging to the *Rutaceæ*: several species of *Zieria* found in southern Australia and Tasmania, and *Toddalia aculeata* found in the mountains of eastern Africa, tropical Asia and the Philippine Islands. (Also see Berberis.)

CIMICIFUGA

Cimicifuga, Black Cohosh, Black Snakeroot or Macrotys (U. S. P. 1820 to 1936, N. F. 1936 to date) consists of the dried rhizome and roots of *Cimicifuga racemosa* (Linné) Nuttall.

The generic name *Cimicifuga* means in Latin "to drive away bugs," in reference to its insect poisonous properties; *racemosa* refers to the flowers in racemes or clusters.

The plant is a perennial herb growing in eastern North America. The

drug is collected in the autumn, most of the commercial supply coming from the Blue Ridge Mountains.

DESCRIPTION.—Rhizome horizontal, with numerous upright or curved branches and few roots; externally dusky brown to dark yellowish brown, slightly annulate from circular scars of bud-scales, the upper surface with buds, stem-scars and stem remnants, the lower and lateral surfaces with numerous root-scars and few roots; fracture horny; internally, dark brown and waxy or sometimes whitish and mealy; bark about 1 mm. in thickness, wood 4 to 5 mm in thickness, and distinctly radiate, pith 3 to 5 mm. in diameter.

Roots brittle, nearly cylindrical or obtusely quadrangular; longitudinally wrinkled; 1 to 3 mm. in diameter; fracture short; internally, wood usually 4-rayed.

FIG 125.—Cimicifuga Transverse section of the central part of a mature root in which the secondary changes are completed *a*, parenchyma; *b*, endodermis, *c*, cambium zone; *d*, tracheæ in secondary xylem, *e*, broad, wedge-shaped medullary rays; *f*, outer portion of one of the primary xylem bundles, *g*, parenchyma beneath the endodermis, *h*, interfascicular cambium. (After Bastin.)

POWDER.—Pale to moderate yellow brown; odor slight; taste bitter and acrid, starch grains numerous, simple or compound, the individual grains from 3 to 15 microns in diameter, spheroidal or more or less polygonal, each with a somewhat central cleft, fragments of tracheæ with scalariform thickenings or bordered pores; wood fibers numerous, thin-walled, strongly lignified; irregular,

yellowish brown fragments of suberized epidermis of tabular cells, sometimes elongated, and with walls considerably thickened. (Also see Fig. 125 and the National Formulary.)

CONSTITUENTS.—Four crystalline principles: two soluble in chloroform, one in ether, and one in w
considerable starch and a
salts, thus distinguishing t

gogue. Its use is empirical. Average dose, 1 gm.

LARKSPUR

Larkspur (U. S. P. 1820 to 1882; N. F. 1916 to 1926 [*D. Consolida*]; N. F. 1916 to date [*D. Ajacis*]) is the dried ripe seed of *Delphinium Ajacis* Linné. The generic name *Delphinium* is from the Greek, meaning "dolphin," so-called because the nectary resembles the figure of a dolphin; *Ajacis* is after Ajax; *Consolida* refers to its supposed power to heal or consolidate wounds.

The plants are annuals, indigenous to central Europe and widely cultivated in America as garden plants. The drug is imported from Europe. Delphinium seeds were employed by the Greeks and Romans as emetics and cathartics, but due to their poisonous nature their internal use has long since been discontinued.

l Formulary The
s in that the rows
orm scale-like pro-
are smaller, up to

delphinine, which crystallizes in rhombic prisms and resembles aconitine in its physiological properties.

c

cide

Staphisagria (U. S. P. 1882 to 1926) is the dried ripe seed of *Delphinium*
e of southern Europe and Asia Minor,
and southern France, from where the

iangular or somewhat tetrahedral, one
side c
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raphé
or on
sperm
embry
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reticulations of the seed coat, 2 or 3 rows of parenchyma cells with more or less irregular thin walls, a thin layer of very small, thick-walled cells with numerous, lattice-like or reticulate pores; endosperm large, composed of polygonal cells enclosing small aleurone grains and fixed oil, the latter forming in large globules on the addition of solutions of hydrated chloral, the alkalies or sulfuric acid.

The powder is grayish-brown or light brown.
Staphisagria contains delphinine and staphisagroine.
Staphisagria is used as a parasiticide.

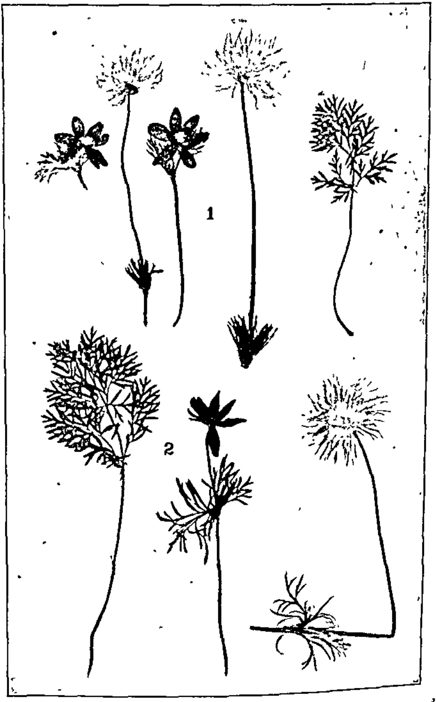

FIG. 126.—*1*, leaf, fruits and flowers of *Anemone pulsatilla* *2*, leaf, flower and fruit of *Anemone pratensis*. The leaves are pinnately divided, the divisions being further incised or dissected

The **tall larkspur** (*Delphinium urceolatum*) is common to the stock ranges of the Western States, and cattle grazing in these territories become poisoned

toxic properties after it has flowered.
properties as the former.
1882 to 1905; N. F. 1916 to 1947) is

United States.

For description of the drug see Figure 126 and the National Formulary, 8th edition.

The powdered drug contains numerous simple, thick-walled hairs up to 2.5 mm. in length and 20 microns in thickness; tracheæ up to 35 microns in width with spiral thickenings, or with simple or bordered pores; fragments of epidermal tissue with broadly elliptical stomata up to 55 microns in length in leaf tissue, and up to 65 microns in length in stem tissue; calcium oxalate crystals and starch grains few or absent. The color of the powder is light olive-brown to dusky greenish yellow, the taste is very acrid.

The drug contains an acrid volatile oil, the principal constituent of which is a camphor (anemonol) The latter is easily decomposed into anemonin to which the activity of the drug is due, an
acrid Similar principles are found in s
species of *Ranunculus* (buttercup) and

Pulsatilla is a diuretic, an alterative, an expectorant and an emmenagogue Average dose, 0.3 gm.

Hepatica, or Liverwc
triloba Chaix. The pl
woods to Europe and
subcoriaceous, smooth,
lobed. The drug may have some tonic and stimulant properties, and may be given freely in infusion.

Ranunculus, or Crowfoot (U S. P 1820 to 1882) is the fresh herb of *Ranunculus bulbosus* Linné, an herbaceous plant up to 45 cm. high with long-petiolate, ternate, hairy radical leaves and yellow flowers The fresh plant is strongly acrid which decreases upon drying It has been applied externally as a counter-irritant It is not used internally

Adonis, or Pheasant's Eye (N F
tion of *Adonis vernalis* Linné. The
blood of the beautiful Adonis, and
low-growing perennial herb indigenous to northern Europe and Asia. The overground portion is collected in the spring, carefully dried and tied into

or wanting.

The drug contains adonidin, a mixture of glucosides having the physiological action of digitalis, and of which picroadonidin is the cardiac principle; also

total ash about 10 per

plant of *Adonis æstivalis*. The drug contains 0.215 per cent of a glucoside, which resembles adonidin, but is weaker in its physiological action.

In *Adonis microcarpa*, growing in Sicily, occurs a principle resembling adonidin.

Coptis, or Goldthread (U. S. P. 1820 to 1882; N. F. 1916 to 1936) is the entire plant of *Coptis trifolia*, a low perennial growing in moist woods and swamps of the northeastern Un

Coptis occurs in loo of the leaves and the odor and bitter taste. obs wh cc. of cold wa tirring and then filtering, gives a golden-yellow solution.

It contains two alkaloids, berberine and coptine, the latter being crystalline and becoming purple on the addition of sulfuric acid and warming. Total ash from 3.75 to 5.25 per cent; acid-insoluble ash about 0.5 per cent.

Coptis is a tonic and a stomachic. It has an action similar to that of hydrastis. Average dose, 2 gm.

The dried rhizome of *Coptis anemonæfolia* and of several other species of *Coptis* is official in the Pharmacopœia of Japan. The rhizome is tuberculate, more or less curved, about 4 cm. in length and from 1 to 5 mm. in thickness; externally grayish yellow, bearing at the crown the remains of the leaf-bases and beset with numerous thin roots; fracture short, fibrous; inner surface with a dark orange-colored cortex, a pale yellow wood, and a large hollow pith; inodorous, taste bitter.

Zanthorrhiza, or Yellow-Root (U. S. P. 1820 to 1882) is the rhizomes and roots of *Zanthorrhiza apiifolia*. growing in eastern United States from much-branched and bent, long and d with few rootlets. The bark is thin, deep yellow; the wood striate, bright yellow. The powdered drug is very bitter and starchy. The drug contains berberine and onic and alterative. Dose, 2 gm.

mas forests of the flowers during plant flowers.

The rhizome is horizontal, with numerous short, knotty branches and moderately long roots; externally grayish black or brownish black, upper surface with numerous stem-bases and depressed circular scars, under and side portions with ht yellow, showing

own, with a thick light brown cortex and a narrow, central, porous, yellowish wood.

It contains two crystalline glucosides, helleborin, a narcotic poison with burning taste, and helleborein, a cardiac stimulant having a sweetish taste. The former giv sulfuric acid, and the latter a deep vio olatile oil, two acrid re n and potassium.

Black hellebore is a heart stimulant, a drastic hydragogue cathartic and an emmenagogue.

It is used somewhat in veterinary practice but its use in medicine is obsolete.

Black hellebore has appeared on the market under the label of "American Hellebore" (see page 150).

Helleborus Fœtidus, or Bear's-foot Hellebore (U. S P. 1820 to 1831) is the leaves of *Helleborus fœtidus*, an English species, often cultivated for its flowers. Now, rarely used in medicine.

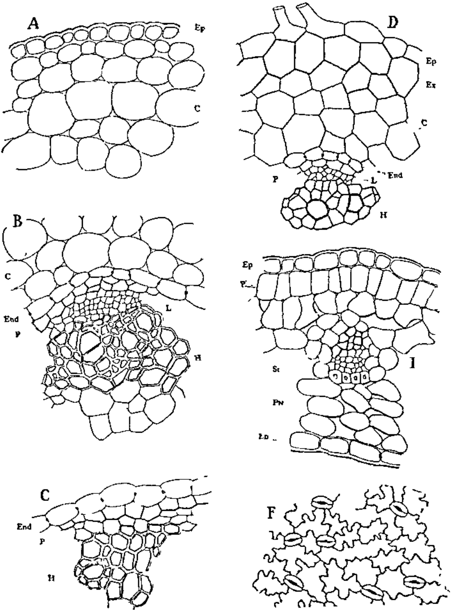

FIG 127 —Coptis *A*, transverse section of peripheral portion of an internode in the rhizome *Ep*, epidermis, *C*, cortex *B*, transverse section of rhizome *C*, cortex, *End*,

and foldings of lateral cell walls. (After Holm.)

BERBERIDACEÆ, OR BARBERRY FAMILY

This is a small family of about 100 species of herbs and shrubs, growing mostly in temperate regions. The flowers are either single or in racemes and the fruit is a berry or capsule. A number of crystalline substances are present and some of these, as berberine, are very characteristic of the plants of this family. The non-glandular hairs are usually unicellular; in some instances they consist of a chain of cells, the terminal one of which is filled with a yellowish or brownish amorphous substance.

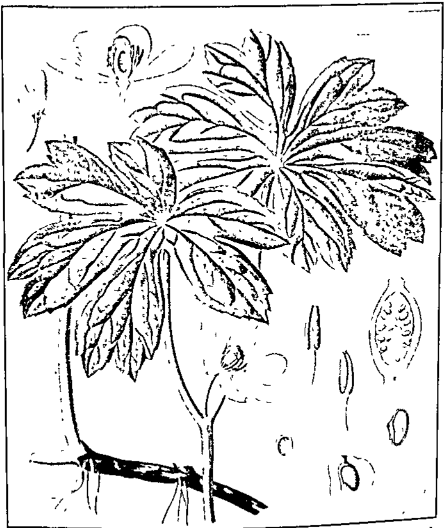

FIG 128 —*Podophyllum peltatum* A portion of the long, horizontal, branched, nearly cylindrical, dark brown rhizome, with internodes 2 to 10 cm. in length, and roots from the underside of the nodes and a stem-scar, aerial stem or bud from the upper side, the two large, peltate, deeply lobed leaves [illegible] from the top of the stem with the large, white- [illegible] (upper [illegible] ovule and the seed in longitudinal section (lower right corner)

PODOPHYLLUM

Podophyllum, Mandrake or May Apple (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the dried rhizome and roots of *Podophyllum peltatum* Linné.

The generic name is from the Greek and means foot-like leaf; *peltatum* means shield-like. The plant is a perennial herb having a long jointed

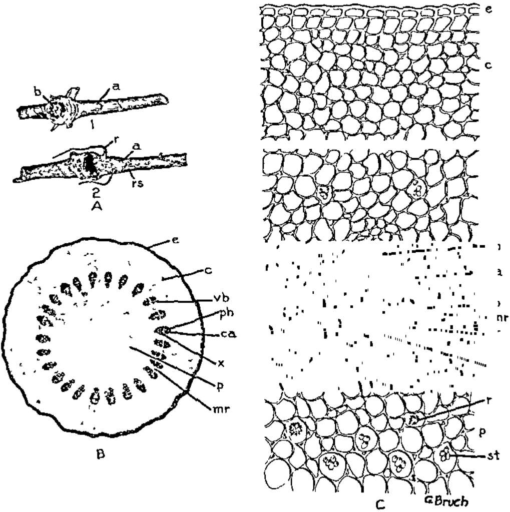

FIG. 129.—*Podophyllum peltatum* A, entire drug showing the nearly cylindrical, jointed rhizome somewhat compressed on the upper and lower surfaces up to 9 mm in diameter (internodes), with thickened nodes, dark brown, longitudinally wrinkled with irregular V-shaped scars (*a*) of the scale leaves The upper view (*1*) shows a large circular depressed stem-scar (*b*), the lower view shows numerous root-scars (*rs*) or roots (*r*) about 2 mm in thickness. The fracture is short, the odor slight and the taste disagreeably bitter and acrid *B*, lens view of a transverse section through the internode of the rhizome showing epidermis (*e*), cortex (*c*), vascular bundles (*vb*), containing phloem (*ph*) and xylem (*x*) separated by cambium (*ca*), medullary rays (*mr*) and pith (*p*) *C*, transverse section from the periphery into the pith with a portion of the cortex omitted, showing epidermis (*e*) with outer and radial walls suberized, cortex (*c*) of parenchyma cells, open collateral vascular bundles (*vb*), phloem (*ph*), xylem (*x*), containing tracheæ (*tr*), cambium (*ca*), and pith (*p*) The cells of the cortex and pith contain single or 2- to 6-compound starch grains (*st*) from 3 to 20 microns in diameter and rosette aggregates of calcium oxalate up to 80 microns across. (Drawing by G Bruch)

and branching rhizome. The rhizomes are dug either early in the spring or in the autumn, after the aërial parts have died down. Most of the commercial supplies come from the Central States and from

Virginia and North Carolina. The drug was long known to the Indians, who introduced it to the early settlers.

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 128 and 129 and the National Formulary.

CONSTITUENTS.—Resin 3.5 to 5 per cent, consisting of two poisonous principles: (a) podophyllotoxin occurring in white crystals that are insoluble in water, and (b) picropodophyllin (an isomer of podophyllotoxin) which crystallizes in needles and is insoluble in water but soluble in 95 per cent alcohol. Podophy" up a molecule of water This acid by loss of w lso contains a yellow, crystalline flavinol, quercetin, a green fixed oil, podophyllic acid, a purgative resin, podophylloresin; considerable starch, and some gallic acid. Total ash 3 25 per cent; acid-insoluble ash 0.4 per cent.

STANDARDS.—Podophyllum yields not less than 5 per cent of resin of podophyllum and contains

USES AND DOSE.—I
tic. It has also been

ALLIED PLANTS —P
emodi, a plant growing on the lower slopes of the Himalayas, is larger and yields 11 4 to 12 per cent of resin, which contains about twice as much podophyllotoxin as the resin obtained from *P. peltatum.*

Podophyllum Resin (U. S. P. 1863 to 1942; N. F. 1942 to date) is prepared by extracting finely powdered podophyllum by slow percolation with alcohol, concentrating the alcoholic extract, and pouring it into acidified water. The precipitated resin is washed twice with water, dried and powdered. It is an amorphous powder varying in color from light brown to greenish yellow and turns darker when subjected to temperatures exceeding 25° C. It has a slight, peculiar, bitter taste and is very irritating to the eye and to mucous membranes. Podophyllum resin is soluble in alcohol with only a slight opalescence, and the solution is acid to litmus. It is only partially soluble in ether and in chloroform.

TESTS —It is soluble in pota forming a deep yellow liquid from which aqueous solution is allowed to taste and turns brown upon f 60 per cent alcohol, follow with e the mixture gently; it does not resin) rastic purgative and hydragogue cathartic. Average dose, 10 mg

Berberis, Oregon Grape Root or Berberis Aquifolium (U. S. P. 1905 to 1916; N. F. 1916 to 1947) consists of the dried rhizome and roots of species of the section *Mahonia* (Nuttall) DeCondolle of the genus *Berberis* Linné. The plants are low trailing shrubs indigenous to the Rocky Mountain region extending into British Columbia and as far east as Nebraska Most of the commercial supplies are gathered in Washington, Oregon and California, chiefly from *Mahonia aquifolium*. Berberis was introduced into American medicine in 1877 by Bundy. The East Indian varieties of *Berberis* were used in medicine by Dioscorides, Pliny and Galen.

See Figures 130, 131 and National Formulary, Edition 1942, for the description, structure and powder.

Berberis contains four alkaloids: namely, berberine; oxyacanthine, which
acqu
solub
gatec
1.83

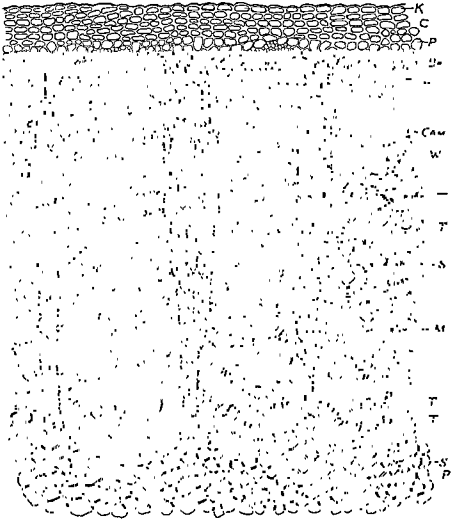

FIG 130 —Transverse section of Berberis rhizome consisting of a few layers of cork (K) a narrow cortex (C) of parenchyma (P), containing yellowish brown amorphous contents. Numerous open collateral fibrovascular bundles separated by medullary rays (M) containing starch (S). Each bundle consists of an outer phloem consisting of alternating rows of bast fibers (BF) and leptome (L), a narrow cambium and a broad xylem consisting of numerous wood fibers (W) intermingled with pitted and reticulate tracheæ (T). A narrow central pith composed of parenchyma (P) containing starch (S) Sections of the root are similar to those of the rhizome except that they exhibit curved medullary rays and show no pith (Drawing by Haase)

Berberis contains not more than 5 per cent of attached overground stems and not more than 2 per cent of other foreign organic matter, and yields not more than 2 per cent of acid-insoluble ash. Pieces of the rhizome or root over 45 mm in diameter or pieces from which the bark has been removed must be rejected.

Berberis is a bitter tonic and an alterative. Average dose, 2 gm.

Berberis Baccæ (U. S. P. 1831 to 1842, N. Y. Edition), the fresh fruit of *Berberis canadensis* Mill (American Barberry) has been used in an acidulous drink as a febrifuge.

Berberis, or Barberry Bark (U. S. P. 1863 to 1882), *the bark of the root of Berberis vulgaris* Linné (European Barberry), *naturalized in the eastern United States*, is a drug with properties similar to those of the Oregon Grape.

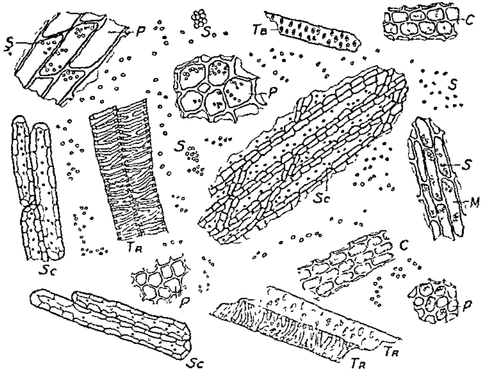

FIG 131 —Powdered Berberis or Oregon Grape —Yellowish brown; consisting of fragments of medullary rays (M) containing starch grains (S) (2- to 3-compound, the

Not only the rhizomes and roots, but also the stem and root barks are employed, the root bark containing a larger amount of alkaloids than that of the stem.

The bark and *root of Berberis asiatica* of the Himalaya region and *B. aristata* of India are similarly employed, the latter containing about 2 per cent of berberine.

The flowers and berries of *Mahonia aquifolium* and *B. vulgaris* contain berberine, oxyacanthine, volatile oil, about 6 per cent of malic acid and 3.5 to 4.7 per cent of sugar.

The alkaloid berberine is also found in *Argemone mexicana* (Fam. *Papaveraceæ*) and in the following members of the *Ranunculaceæ: Hydrastis canadensis, Coptis trifolia*, and *Zanthorhiza apiifolia*.

CAULOPHYLLUM

Caulophyllum or Blue Cohosh (U. S. P. 1882 to 1905; N. F. 1916 to date) consists of the dried rhizome and roots of *Caulophyllum thalic-*

troides (Linné) Michaux. The generic name is from two Greek words meaning a stem-leaf, in reference to the overground characteristic of the plant; *thalictroides* means "like meadow rue" and is also of Greek origin.

The plant is a perennial herb having a more or less crooked horizontal rhizome. It is indigenous to the eastern part of the United States and Canada. Caulophyllum was used by the American Indians as a parturient.

D[illegible] with a few upright branches, from 7 to [illegible] in thickness, externally grayish brown [illegible] face with numerous depressed cup-shap[illegible] id lateral portions with numerous gray [illegible] yellowish brown, matted branching roots, the fracture of the rhizome is rough and woody and of the roots tough, the rhizome has, when smoothly cut, a waxy luster and shows a thin bark, numerous small wood wedges and a large pith The root consists of a thick cortex of starch-bearing parenchyma, and a 4-rayed xylem

POWDER.—Pale to yellowish brown, odorless but sternutatory and with an acrid and bitter taste; the powder shows numerous starch grains from 3 to 18 microns in diameter, mostly simple, somewhat spheroidal in shape; fragments of cork having yellowish brown walls, tracheæ from 25 to 50 microns in width, with bordered pores, scleren[illegible] with strongly lignified walls, tracheids w[illegible] starch-bearing parenchyma

CONSTITU[illegible] hylcytisine (caulophylline), a crystalline [illegible] second saponin-like glucoside, caulophyllos[illegible] which the name citrullol has been applied, a phytosterol, and a mixture of fatty acids Total ash 3.3 per cent; acid-insoluble ash 0.5 per cent

STANDARDS —Caulophyllum contains not more than 3 per cent of foreign organic matter and yields not more than 4 per cent of acid-insoluble ash.

USES AND DOSE.—Caulophyllum is said to be an antispasmodic, an emmenagogue and a diuretic Average dose, 0 5 gm

MENISPERMACEÆ, OR MOONSEED FAMILY

This family, comprising about 300 genera, consists mostly of tropical plants which are in the nature of climbing or twining, frequently woody, vines. The leaves are entire or lobed, the flowers are small, white or green, and diœcious. The stems are characterized by having broad primary medullary rays, and in the pericycle there is usually a continuous sclerenchymatous ring. The tracheæ are porous, very wide and are associated with tracheid-like wood fibers. In certain of the genera in which the stem is thick and woody an anomalous structure is found, consisting of several rings of vascular bundles, which rings are concentric or may develop eccentrally; that is, more strongly on one side, as in Pareira Calcium oxalate usually occurs and both glandular and non-glandular hairs may be present; peculiar hydathodes, *i. e.*, water-absorbing and water-excreting organs, are observed situated among the trichomes in *Anamirta cocculus* Elongated secretory sacs occur in the stems and petioles of *Cissampelos*, *Jateorrhiza* and *Anamirta* A sub-epidermal mucilaginous layer occurs in a number of species.

CALUMBA

Calumba or Colombo (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried root of *Jatcorrhiza palmata* (Lamarck) Miers. The generic name is derived from two Greek words, *meaning a healing root. Palmata* refers to the leaves which are palmately lobed. The name calumba is derived from *kalumb*, the native African name for the root.

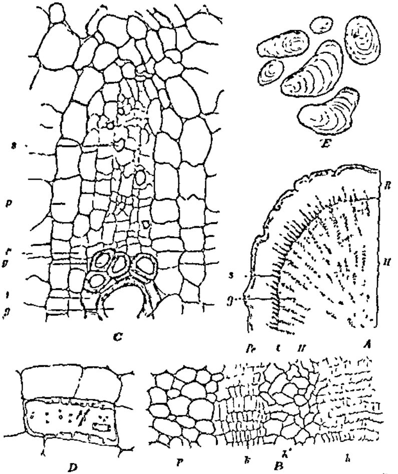

FIG. 132.—Calumba· *A*, transverse section showing bark (*R*), cambium (*C*) and wood (*H*), wood fibers (*H*), tracheæ (*g*), periderm (*Pe*) and phloem (*s*), *B*, transverse section of periderm showing parenchyma (*p*), small-celled cork (*k*) and large-celled cork (*k'*), *C*, ... fiber (*i*), cambium ...ontaining calcium

The plant is a perennial woody climber indigenous to Mozambique and Madagascar. The roots are dug in the dry season (March), separated from the rhizomes, cut into transverse or oblique slices, and dried in the shade. Calumba seems to have come into general use during the latter part of the eighteenth century.

DESCRIPTION.—In nearly circular or elliptical disks, sometimes irregularly bent, up to 10 cm. in diameter and 20 mm. in thickness; the bark is 4 to 6 mm. in thickness with a distinct cambium zone; externally pale reddish brown to light olive-brown and coarsely wrinkled; fracture short, mealy; the cut surface

is yellowish and radiate, the collateral bundles forming a concentric zone; center usually depressed.

STRUCTURE.—See Figure 132 and the National Formulary.

aromatic, very bitter; crons in length, ovoid, with eccentral, linear, irregularly thickened, ntaining one or more

CONSTITUENTS.—Several yellowish alkaloids, closely resembling berberine and varying from 0 98 to 1.38 per cent in the bark and 1 02 to 2.05 per cent in the wood. To some of these bases the names columbamine, palmatine and jateorrhizine have been given. Calumba also contains a volatile oil, 0 056 per cent, starch, about 35 per cent; pectin, 17 per cent; resin, 5 per cent; calumbic acid; calcium oxalate, and mucilage. Total ash, 6 32 per cent; acid-insoluble ash, 0.49 per cent.

STANDARDS —Calumba contains not more than 1 per cent of foreign organic matter, and yields not more than 2.5 per cent of acid-insoluble ash.

USES AND DOSE.—Calumba is a bitter tonic. Since it contains no tannin, it may be prescribed with iron salts, and does not cause constipation. Average dose, 1 gm.

ADULTERANTS AND SUBSTITUTES.—Calumba is rarely adulterated, although the following have been found either as admixtures or sold under the name of calumba

1. **Calumba rhizome,** *in distinctly radiate disks up to 3 cm. in diameter,* without depressed centers

2 **Ceylon Calumba,** the stem of *Coscinium fenestratum,* occasionally found in dark yellow slices which show distinct medullary rays and crescent-shaped bands of sclerenchyma outside of the phloem patches. It is very woody and the center is not depressed.

3. **American Calumba,** the bitter root of *Frasera carolinensis* Fam. *Gentianaceæ* occurs in transverse disks somewhat resembling calumba, but without radiate structure.

4 The roots of *Tinospora bakis,* a tropical African plant, have also been found in the market

Menispermum, or Canada Moonseed (*U. S. P* 1831 to 1842, *N Y* edition, 1882 to 1905) is the dried rhizome of *Menispermum canadense* This plant is a high-climbing vine, indigenous to the northern United States and Canada and having broadly ovate, cordate and 3- to 7-lobed leaves The long slender rhizome, cut into convenient pieces and dried, is horizontal, cylindrical, much branched, and attains a diameter of 20 mm , it is yellowish to dark brown, longitudinally wrinkled and somewhat scaly, having nodes, buds, circular overground stem-scars and scattered roots; fracture tough and very fibrous, the rhizome has a thin bark, a broad porous radiating wood, and a white pith which is frequently hollow in the larger pieces, inodorous; taste bitter and somewhat sweetish. Roots cylindrical, more or less branching, from 0.5 to 2 mm in diameter, dark brown, tough, wiry The structure is shown in Figure 133

an

dendron tomentosum, a perennial climber indigenous to Brazil and Peru. The commercial article (see Fig 134) is exported from Rio Janeiro, is nearly cylindrical, more or less tortuous, cut into pieces up to 20 cm. in length, and varying from 1 to 6 cm. in diameter; externally brownish black with transverse ridges

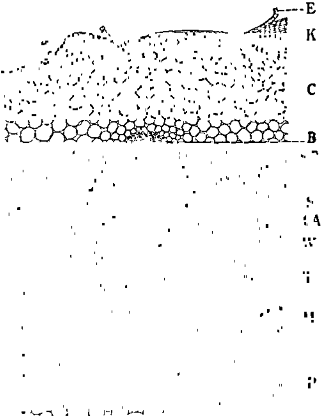

Fig 133.—Menispermum. Transverse section through rhizome: *E*, epidermis; *K*, subepidermal cork, *C*, cortex, *B*, bast fibers, *S*, sieve; *ST*, stone cells, *CA*, cambium; *T*, large tracheæ or vessels, *W*, wood fibers; *M*, medullary ray cells, *P*, pith.

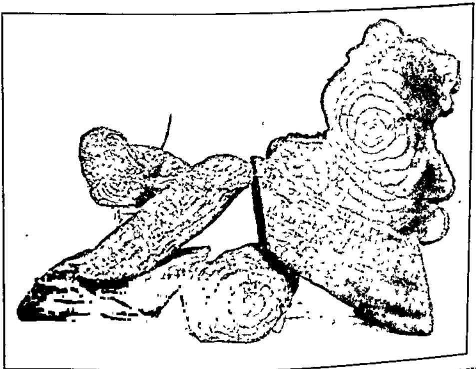

Fig 134.—Photographs of typical specimens of true Pareira, the pieces in transverse section showing concentric rings of fibrovascular tissue.

cells; odor slight; taste very bitter.

Pareira contains several alkaloids, bebeerine (pelosine), isobebeerine, β-chondrodendrine, β-bebeerine, and chondrodine. A mixture of the sulfates of these alkaloids constitutes the commercial bebeerine sulfate.

Pareira is used as a bitter tonic, an antipyretic, and a diuretic. Average dose, of the drug, 2 to 4 gm ; of bebeerine sulfate as a tonic, 30 to 100 mg , as an antipyretic, 0.2 to 1 gm.

Allied Plants.—White Pareira is obtained from *Abuta rufescens*, the roots

bundles, and contains about 0 5 per cent of pelosine.

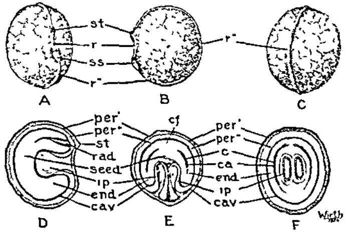

Fig 135 —Cocculus Fruits spheroidal, ovate or subreniform, 8 to 13.5 mm long, 7 to 11 mm. wide and 7 to 10 mm thick, wrinkled, blackish brown or reddish brown.

section cut at right angles to the ridge plane, showing the outer brownish layer (*per'*) and the inner yellowish layer (*per"*) of the pericarp (about 1 mm. thick), the reniform seed (*seed*) and the ventral infolding of the pericarp (*ip*). The embryo consists of thin cotyledons (*c*) embedded in longitudinal cavities (*ca*) in the endosperm (*end*) The radicle (*rad*) is visible in the vertical section *Cav*, cavi-endosperm (*end*) The radicle (*rad*) is visible in the vertical section. *Cav*, cavities due to shrinkage, *cf*, fat crystals in the endosperm (Drawings by Wirth)

Nectandra, or Bebeeru Bark (U S P 1863 to 1882) is the dry bark of *Nectandra Rodiæi* (Fam. *Lauraceæ*), the greenheart tree, 60 to 100 feet high, growing on hill-sides in British Guiana near the sea. The wood is very durable The bark is in flat, brown pieces about 6 mm thick. It is astringent and very bitter in taste. It contains the alkaloid bebeerine (pelosine) and the bark has been used for the production of this alkaloid or mixture of alkaloids.

The wood of the **boxwood** (*Buxus sempervirens*, Fam. *Sapindaceæ*) contains an alkaloid, buxine, resembling bebeerine.

Cocculus, or Cocculus Indicus (N. F. 1916 to 1947) is the dried ripe fruit of *Anamirta cocculus* (Linné) Wight et Arnott.

The plant is a woody climber growing in the mountainous woods of southeastern Asia, particularly along the Malabar coast. The fruits are commonly used by the natives to stupefy fish, thus making it possible to catch them by hand. When ripe they are of a reddish color and are removed from their stalks and dried. The drug seems to deteriorate with age, and those fruits which are of a dark color, having the seeds well preserved, are preferred.

Description and Structure.—See Figure 135.

Powder.—Moderate yellowish brown; odorless; taste bitter, the seed intensely ... upon the addi- ... ng aleurone ... lar crystals, ... ter, alcohol or potassium hydroxide T.S.; numerous thick-walled, mostly non-lignified fibers; tracheæ spiral.

Constituents.—Picrotoxin 1.5 per cent; fixed oil up to 25 per cent, consisting chiefly of stearic and oleic acids; the pericarp contains two tasteless, non-toxic, crystallizable alkaloids, vis menispermine and para-menispermine. Total ash, about 5.5 per cent; acid-insoluble ash, about 0.15 per cent.

Cocculus is a convulsant poison and the tincture is used as a parasiticide.

Picrotoxin, or Cocculin (U. S. P. 1882 to 1905, 1942 to date) is a glycoside obtained from the seed of *Anamirta paniculata* Colebrooke.

... color- ... les

Picrotoxin has been used as an antihidrotic, and as an antidote in barbiturate poisoning, also in ointments as a parasiticide, but it is considered dangerous. It is very poisonous. Dose, subcutaneous, 2 mg.

MAGNOLIACEÆ, OR MAGNOLIA FAMILY

The plants of this family are mostly trees or shrubs and are represented in the United States by the magnolias and the tulip tree which is also called yellow poplar or white wood. The plants are characterized by having in the pericycle small isolated groups of bast fibers. The pith is frequently hollow, surrounded by more or less empty cells, those at the periphery being thick-walled and living. The stone cells are of various shapes, being not infrequently much branched, as in magnolia. Calcium oxalate occurs in the form of small octahedral or prismatic crystals or in rosette aggregates, seldom in the form of large prisms. An important character is the presence of more or less spheroidal secretory cells which are distributed in the parenchyma of the stem and leaves, and contain either a volatile oil or resin. In the leaves they give rise to pellucid dots, which are apparent on holding the leaves to the light.

Magnolia (U. S. P. 1820 to 1894) is the dried bark of *Magnolia virginiana* Linné (*M. glauca* or Sweet Bay) or of other species of *Magnolia*. The bark from

the younger branches of
and bitter in taste The
to be thicker, darker in
pungency appear to be
dendrin.

The bark has been used as a bitter tonic, antimalarial and diaphoretic. The dose is about 2 gm. in tincture or decoction.

Illicium, Chinese Anise or Star Anise (U. S P 1882 to 1905) is the dried,

most of the pharmacopœias as such. The carpels of the flower are erect, assuming a horizontal position after fertilization, and the fruit is collected usually when the first follicles are well dehisced

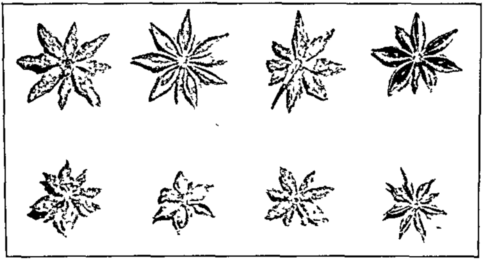

Fig 136.—Chinese star anise (above) and Japanese star anise (below). (Photo by R. S. Adamson)

The fruit (see Fig. 136) consists of 6 to 11 (usually 8) outspreading boat-shaped follicles, arranged around a central axis, each carpel containing a single, shiny brown seed The fruit is brown in color, externally rough, but on the

cells are absent.

Illicium yields a
6 per cent from the
also contains a red
catechuic acid and

Illicium is used as a stimulant carminative. Average dose, 1 gm ; of the volatile oil, 0 1 cc

Japanese Star Anise, Shikimmi or Skimmi, the fruit (see Fig. 136) of *Illicium religiosum* (also known as *I. japonicum* and *I anisatum*), is very poisonous, and is obtained from trees which are extensively cultivated in Japan, especially in groves of Buddhist temples. The fruits may be dangerous because of their resemblance to Chinese star anise, but the two kinds are seldom mixed The carpels (see Fig. 136) are somewhat smaller than illicium, the summit being

acuminate and terminated by a short curved beak. Their odor is different from anise and resembles oil of sassafras or laurel. The taste is intensely pungent, becoming aromatic, somewhat bitter and camphor-like.

The Japanese star anise yields 1 per cent of a volatile oil; and skimmin, which forms large crystals that are soluble in alcohol, but insoluble in water, and to which the poisonous properties are due. An alcoholic solution of the carpels, upon evaporation, yields numerous crystals of shikimminic acid.

Liriodendron, or Tulip-tree Bark (*U. S. P. 1820 to 1882*) is the bark of *Liriodendron Tulipifera* Linné. The plant is a stately tree rising to 140 feet and indigenous to the eastern United States from Vermont and Michigan to eastern Kansas and the Gulf of Mexico.

[illegible] colored fibrous [illegible]

and diuretic. The dose is 4 *gm.* in tincture or infusion.

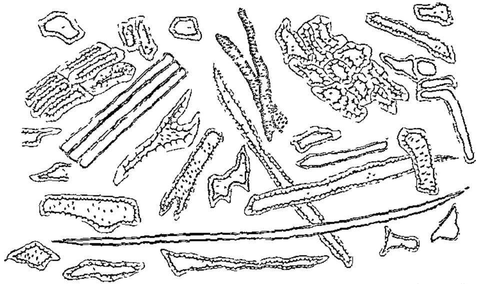

FIG. 137.—Various forms of stone cells in star anise, the fruit of *Illicium verum*.

Wintera, or Winter's Bark (*U. S. P. 1820 to 1863*) is the bark of *Drimys Winteri* Forster. The plant is a small tree found in western South America. The bark is rather thin, inclined to quill, mostly light gray on the outer surface and brown on the inner surface. The odor is distinctive, aromatic and the taste aromatic and pungent. The bark contains a volatile oil and about 10 per cent of a soft pungent resin. It is used as a tonic and stomachic. Dose, 2 gm.

MYRISTICACEÆ, OR NUTMEG FAMILY

This is a small family, consisting of about 80 species of tropical trees and shrubs. The leaves are entire and evergreen, the flowers are small, and the plants are diœcious. The fruit is a fleshy capsule and the seeds are covered by a fleshy arillus. [illegible] cells with suberized walls and containing a semiflui[illegible] which is variously colored from yellow o[illegible]stributed in all parts of the plant. Calcium oxalate occurs in the form of small needle-shaped crystals, which frequently are arranged in aggregates. The hairs are of stellate type and are very characteristic for several of the species.

MYRISTICA

Myristica or Nutmeg (U. S. P. 1820 to date) is the dried ripe seed of *Myristica fragrans* Houttuyn, deprived of its seed coat and arillode and with or without a thin coating of lime. The tree is indigenous to the Molucca and neighboring islands, and is now extensively cultivated in other tropical regions, including the West Indies. The botanical name *Myristica fragrans,* refers to the fragrance of the nutmeg. The com-

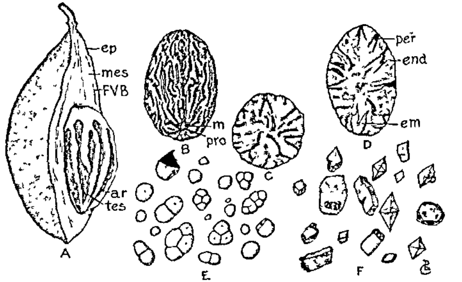

Fig 138 —Myristica. *A*, fruit with half of the pericarp removed *ep*, epicarp, *mes*, mesocarp with fibrovascular bundles (*FVB*), *ar*, the fleshy branched ... arillode which ... kernel of ... dried), ov ... light brow ... white, sm ... pyle (*m*, ... from ... raphé, ... brown ... penetr... in an ir ... strongly ... microns in diameter ... aleurone from nutmeg showing large rhombohedral protein prisms, both *E* and *F* shows about 250 magnification. (Drawing by P. D. Carpenter)

mercial supply is largely derived from the Malay Archipelago, particu larly the Banda Islands, and the Grenadine Islands. The trees bear continuously, two or three crops being collected yearly. The fleshy ... ch when dried constitutes ... three to six weeks, after ... cracked off. With the exception of those from Penang, nutmegs are partially coated with lime to protect them from attacks by insects. Nutmegs were introduced into Europe by the Arabs about the middle of the twelfth century, but not until the sea routes

to the Indies were opened in the sixteenth century did they become a prevailing article of commerce. They played an important part in the Dutch spice monopoly until the tree began to be cultivated in other parts of the world (1800 A.D.)

DESCRIPTION, STRUCTURE AND POWDER.—See Figure 138 and the U. S Pharmacopœia.

CONSTITUENTS.—Fixed oil, 25 to 40 per cent, solid at ordinary temperatures, sometimes occurring in prismatic crystals, and known as "Nutmeg Butter," volatile oil, 8 to 15 per cent; proteins in considerable amounts; and starch.

STANDARDS.—Nutmeg contains not less than 25 per cent of non-volatile ether extract, not more than 10 per cent of crude fiber, not more than 5 per cent of total ash, and not more than 0.5 per cent of acid-insoluble ash.

USES AND DOSE.—Myristica is a condiment, an aromatic and a carminative Average dose, 0 5 gm.

ADULTERANTS.—Kernels that are wormy or more or less broken should be

ALLIED PRODUCTS.—**Macassar Nutmeg or Papua Nutmeg** is the dried seed of *Myristica argentea*, deprived of its testa. Other species of *Myristica* yield nutmegs which are used by the natives, as *M. succedanea* of Timor, *M. fatua* of the Indian Archipelago, and *M. kombo* of Guinea. The kernels of the seeds of *M. fatua* constitute the **long, wild, or male nutmeg.** They are narrow-ellipsoidal, feebly aromatic and have a more or less disagreeable taste. The seeds of *M officinalis* and *M bicuhyba* of Brazil have medicinal properties, a balsam being obtained from the latter and used as a substitute for copaiba. The so-called African nutmegs d ... West Indies soon lose their odorous proper ... d oil which has but little odor of nutmeg ... hose of nutmeg are found in the "American nutmegs" obtained from *Cryptocarya moschata* (Fam. *Lauraceæ*) of Brazil.

Myristica Oil, or Oil of Nutmeg (U. S. P. 1820 to date) is the volatile oil distilled from Myristica.

DESCRIPTION AND TESTS —Oil of nutmeg is a colorless or pale yellow liquid having the characteri ... in an equal volume of alcohol anc ... 0.880 to 0.910 at 25° ... 25° C ; refractive index, 1.474 to 1.488 at 20° C. Upon evaporation ... bath the oil should yield a residue not greater than 2 per cent.

USES AND DOSE.—A carminative and flavoring agent, externally a parasiticide Average dose, 0.03 cc

Mace (U. S P 1851 to 1905; N F. 1916 to 1926) is the arillode of the seed of *Myristica fragrans* Houttuyn According to Warburg, the arillode arises in the region of the hilum before the flower opens and fertilization is effected. The mace, as it occurs on the seeds (see Nutmeg) recently collected is of a brilliant red color It is removed by hand, driec ... a yellowish or orange-brown color. It is usually shipp ... on. The genuine article is usually referred ... the

Mace occurs in coarsely reticulate ... h a whole having the outline of the nutmeg, the basal por... small, irregular opening, usually in compressed nearly entire pieces, reddish or

orange-brown, somewhat translucent, brittle when dry; and with an aromatic odor and taste

For the structure see Figure 139.

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globules a light orange-red color, which is more or less permanent and does not become reddish brown.

Mace contains an aromatic balsam 24.5 per cent; volatile oil 4 to 7 per cent, containing a larger percentage of terpenes than nutmeg oil, fixed oil; starch; and from 2 to 4 per cent of dextrogyrate sugar.

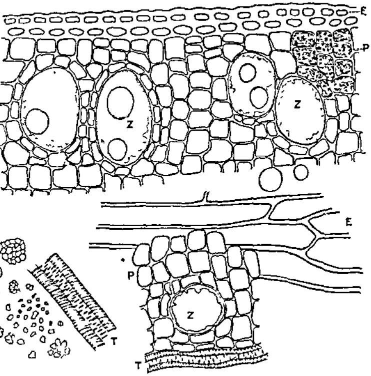

FIG 139 —Mace *E*, epidermal cells, which in transverse section are nearly isodiametric, but in longitudinal section are elongated, sometimes being 1 mm. in length, *P*, parenchyma cells with small starch grains which are colored reddish with iodine (amylodextrin), *Z*, large oil cells up to 65 microns in diameter, and showing oil globules and protoplasmic contents lining the walls, *T*, tracheæ, *S*, small, irregular starch grains up to 10 microns in length

Mace contains not less than 20 per cent and not more than 30 per cent of non-volatile ether extract, not more than 10 per cent of crude fiber, not more than 3 per cent of total ash and not more than 0 5 per cent of acid-insoluble ash.

Mace is a condiment, an aromatic and a carminative. Average dose 0 5 gm.

ALLIED PRODUCTS – **Macassar or Papua Mace,** derived from *Myristica argentea*, is somewhat darker, with broader segments than true mace, and possess

distinguished from true mace in that the entire mace is narrow-ellipsoidal, the

reticulations are not so coarse, the summit is divided into numerous narrow lobes and it is darker in color. With alkalis or sulfuric acid, wild mace assumes a darker red color than the true mace. It is slightly aromatic, but has little value as a spice and yields nearly 60 per cent of non-volatile ether extract.

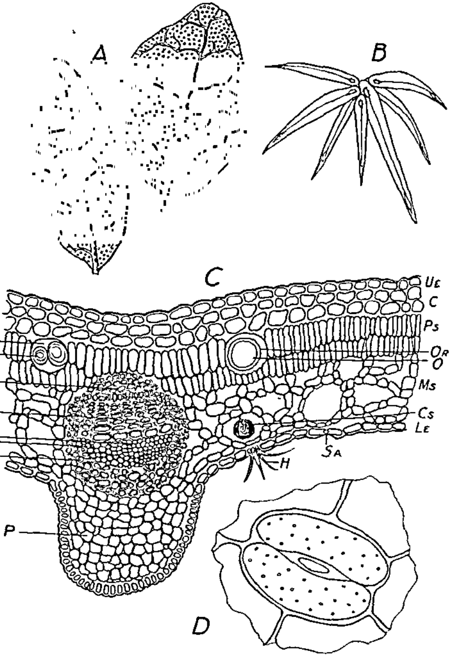

FIG. 140 —Boldo A, leaves showing branching veins and small circular glandular [illegible] transverse section through [illegible]

Bombay mace is used to adulterate genuine mace and is usually suspected when a powdered article has a pronounced reddish color. It can readily be

distinguished by its more numerous oil cells and the fragments being colored bright red upon mounting the powder in concentrated sulfuric acid or a solution of potassium hydroxide. When mounted in hydrochloric acid the fragments become greenish.

MONIMIACEÆ, OR MONIMIA FAMILY

The plants are mostly tropical trees or shrubs having opposite leaves and cymose flowers. They are especially distinguished by the presence of oil-secretion cells, which give an aromatic odor and a transparent dotting to the leaves (Fig. 140).

Boldo, or Boldus (N F. 1916 to 1936) is the dried leaves of *Boldu boldus* (Molina) Lyons, an evergreen tree indigenous to Chili.

The leaves are broadly elliptical or ovate, 3 to 7 cm in length, 1 to 5 cm. in breadth; with the apex acute, rounded, emarginate, the base acute or more or less rounded; the margin entire, distinctly revolute, the upper surface light green, with numerous small spherical projections and depressed veins; the under surface brownish green, the veins very prominent, pubescent, and the surface between the veins minutely and coarsely papillose; the petiole 1 to 5 mm long; the texture coriaceous, brittle; the odor aromatic; and the taste aromatic and pungent.

For the structure see Figure 140.

The drug contains a volatile oil, 2 per cent, an alkaloid, boldine, which is bitter, very slightly soluble in water and soluble in alcohol, ether and chloroform, 0 1 per cent; a glucoside, boldoglucin, a resinous substance and tannic acid. Total ash about 9.45 per cent with about 5.95 per cent of acid-insoluble ash.

Boldo is an aromatic stimulant and mild diuretic Average dose, 0 5 gm.

LAURACEÆ, OR LAUREL FAMILY

This is a family of aromatic shrubs and trees, comprising about 40 genera and 1000 species. T [illegible] a few of the genera are ra [illegible] secretion cells are found i [illegible] fragrance. Many of the plants also contain mucilage cells. These may occur in the same parts of the plant as the secretion cells, and it has been suggested that there is a relationship between the two. It is well known that in those varieties of cinnamon which are deficient in oil there is an increase in the number of mucilage cells, and *vice versa*. The mucilage cells are usually somewhat elongated and are distributed in the palisade tissue of leaves and the cells of the inner bark and pith. The hairs are non-glandular, unicellular and occasionally sclerenchymatous. The stone cells of the inner bark are usually unequally thickened and frequently are U-shaped.

CINNAMON

Cinnamon was first recognized in the U. S. Pharmacopœia of 1820, using the plant name *Laurus cinnamomum*. Linné applied this name to the Ceylon cinnamon plant. In 1820 Cassia or Chinese cinnamon also was recognized under the name *Laurus Cassia*. The U S Dispensatory of 1833 states: "*Laurus cinnamomum* is a native of Ceylon where it

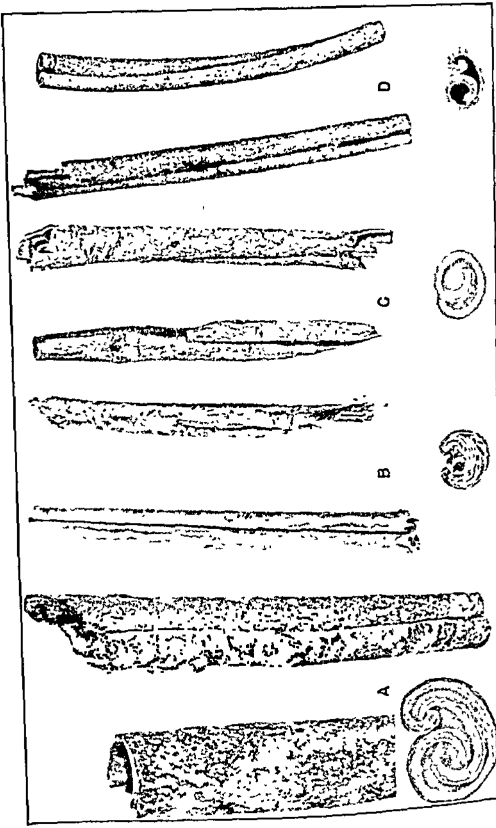

Fig. 141.—Cinnamon Bark Quills in longitudinal and transverse view. A, Saigon; B, Ceylon; C, Cassia and D, Batavia. (Photograph by Paul D. Carpenter.)

has long been cultivated for the sake of its bark. *Laurus cassia*, growing in China and Cochin China is considered by some authors as a distinct species. In odor and taste its bark resembles cinnamon bark, though less pleasant."

The Pharmacopœial recognition of cinnamon may be classified as follows:

Ceylon Cinnamon, U. S. P. 1820 to 1926; N. F. 1947 to date.
Laurus cinnamomum Linné, U. S. P. 1820 to 1842.
Cinnamomum zeylanicum Breyne, U. S. P. 1842 to 1926; *Cinnamomum zeylanicum* Nees, N. F. 1947 to date.

Cassia Cinnamon, U S. P. 1820 to 1905.
Laurus Cassia Aiton, U. S. P. 1820 to 1842.
Cinnamomum aromaticum Nees, U. S. P. 1842 to 1882.
Cinnamomum, undetermined species grown in China, U. S. P. 1882 to 1905.

Saigon Cinnamon, U. S. P. 1894 to date.
Undetermined species of *Cinnamomum*, U. S P. 1894 to 1926.
Cinnamomum Loureirii Nees, U. S. P. 1926 to date.

Oil of Cinnamon or Oil of Cassia, U. S. P. 1820 to date.
Laurus Cinnamomum Linné, U. S. P 1820 to 1842.
Cinnamomum zeylanicum Breyne, U. S. P. 1842 to 1894.
Cinnamomum aromaticum Nees, U. S. P. 1842 to 1863.
Cinnamomum Cassia Blume, U. S. P. 1882 to date.

The latest U. S. Pharmacopœial or National Formulary definitions of Cinnamon are as follows:

Cinnamon or Saigon Cinnamon is the dried bark of *Cinnamomum Loureirii* Nees.

Ceylon Cinnamon is the dried inner bark of cultivated trees of *Cinnamomum zeylanicum* Nees.

Cassia or Chinese Cinnamon is the bark of the shoots of one or more undetermined species of *Cinnamomum* grown in China.

Cinnamon Oil is the volatile oil distilled with steam from the leaves and twigs of *Cinnamomum Cassia* (Nees) Nees ex Blume, rectified by distillation.

An unofficial cinnamon found occasionally in U. S. commerce is **Batavia, Fagot or Java Cinnamon** obtained from *Cinnamomum Burmanni* Blume

Cinnamon may be from the Arabic, *kinnamon*, or Malayese, *kaju manis* (sweet wood); or the Hebrew, *ginnamon*. *Loureirii* is in honor of the French botanist Loureiro; *zeylanicum* signifies Ceylon; *Cassia*, from the Greek *kassia* meaning "to strip off the bark." *Burmanni* refers to Johannes Burman, a Dutch botanist of note. *Saigon* is the capital of French Indochina; *Batavia* in Java is the capital of the Dutch East Indies

Cinnamon as a spice is of great antiquity. It is named in the books of Moses, by the ancient Greek and Latin historians, and in Chinese herbals as early as 2700 B C. Its cultivation in Ceylon probably dates from 1200 A.D.

The wild Cinnamon trees seldom exceed 30 feet (9 meters) in height. The leaves are coriaceous, green and glossy; the small flowers are in terminal panicles and the fruit is fleshy and ovoid.

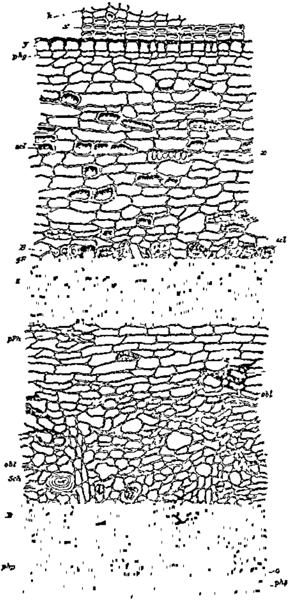

FIG. 142.—Transverse section of cassia cinnamon bark *k*, cork; *x*, thick-walled lignified cork cells *y*, cork cells the outer walls of which are thickened, *phg*, phellogen; *scl*, stone ... parenchyma, *z*, paren- ... ollapsed ... rch and ... Oesterle.)

Practically all commercial cinnamon now is obtained from cultivated trees in Ceylon, southeastern China, French Indochina, Java and many other localities, including the West Indies. However, cinnamon from southeastern Asia and adjacent islands is superior in quality.

The bark is gathered from young trees usually under six years old

and, in Ceylon, mostly from coppice shoots eighteen to thirty-six months old. The leaves, branches and stem tips are distilled with steam for the volatile oil. The bark is cut transversely and longitudinally and peeled. In Ceylon and Java it is scraped while fresh to remove epidermis and cork, in China it is planed to partially remove the cork. In Ceylon, after drying, many layers of the thin inner bark are rolled into one quill; in Java, several layers may be quilled together; and in China and Indochina each layer is quilled separately or but two or three layers together. Formerly, Chinese cassia from wild trees was in thicker, flat pieces known as **Cassia Lignea.**

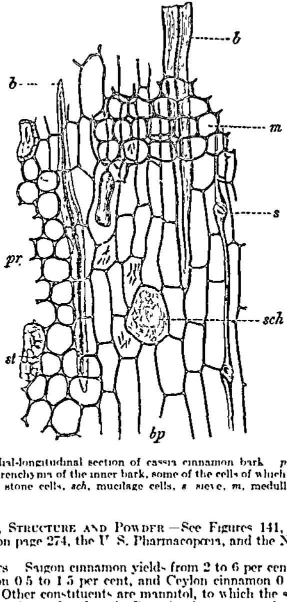

FIG. 143.—Radial-longitudinal section of cassia cinnamon bark. *pr*, parenchyma of outer bark, *bp*, parenchyma of the inner bark, some of the cells of which contain raphides, *b*, bast fibers, *st*, stone cells, *sch*, mucilage cells, *s*, sieve, *m*, medullary rays. (After Moeller.)

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 141, 142, 143, 144, the tabulation on page 274, the U. S. Pharmacopœia, and the National Formulary.

CONSTITUENTS. Saigon cinnamon yields from 2 to 6 per cent of volatile oil, Cassia cinnamon 0.5 to 1.5 per cent, and Ceylon cinnamon 0.5 to 1 per cent of volatile oil. Other constituents are mannitol, to which the sweetness of the bark is due; mucilage, abundant in Batavia cinnamon, and tannin, more in Cassia cinnamon.

The wild Cinnamon trees seldom exceed 30 feet (9 meters) in height. The leaves are coriaceous, green and glossy; the small flowers are in terminal panicles and the fruit is fleshy and ovoid.

FIG 142 —Transverse section of cassia cinnamon bark k, cork; x, thick-walled lignified cork cells, y, cork cells, the outer walls of which are thickened; phg, phellogen, scl, stone cells; x, parenchyma cell with large pores, B, bast fibers; gR, short sclerenchyma, z, parenchyma separating the groups of sclerenchymatous tissue; pPh, protophloem; obl, collapsed sieve; Sch, mucilage canals, php, phloem parenchyma, o, oil cells. (After Tschirch and Oesterle)

Practically all commercial cinnamon now is obtained from cultivated trees in Ceylon, southeastern China, French Indochina, Java and many other localities, including the West Indies. However, cinnamon from southeastern Asia and adjacent islands is superior in quality.

The bark is gathered from young trees usually under six years old

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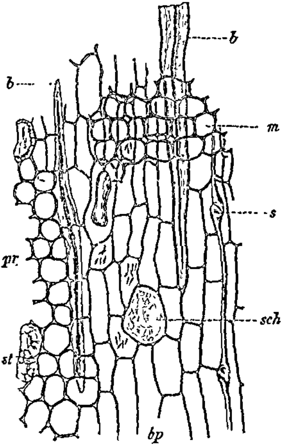

FIG. 143.—Radial-longitudinal section of cassia cinnamon bark. *pr*, parenchyma of outer bark, *bp*, parenchyma of the inner bark, some of the cells of which contain raphides, *b*, bast fibers, *st*, stone cells, *sch*, mucilage cells, *s*, sieve, *m*, medullary rays. (After Moeller.)

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 141, 142, 143, 144, the tabulation on page 274, the U. S. Pharmacopœia, and the National Formulary.

CONSTITUENTS. Saigon cinnamon yields from 2 to 6 per cent of volatile oil, Cassia cinnamon 0.5 to 1.5 per cent, and Ceylon cinnamon 0.5 to 1 per cent of volatile oil. Other constituents are mannitol, to which the sweetness of the bark is due; mucilage, abundant in Batavia cinnamon; and tannin, more in Cassia cinnamon.

STANDARDS.—Saigon cinnamon yields not less than 2.5 per cent of volatile oil, and contains not more than 2 per cent of foreign organic matter. Total ash does not exceed 6 per cent.

USES.—Cinnamon is an aromatic, carminative and a mild astringent.

Important differences between the four common cinnamons are given in the following table:

	Saigon	Ceylon	Cassia	Batavia
Form	Single quills	Compound quills	Single quills	Usually double quills
External surface	Unscraped	Cork and cortex removed	Partially scraped	Scraped
Color of powder	Reddish brown	Light brown or yellowish brown	Reddish brown	Light reddish brown
Odor of powder	Aromatic, characteristic	Fragrant, delicately aromatic	Strongly aromatic	Weakly aromatic
Taste of powder	Aromatic and pungent	Warmly aromatic, delicate, and sweet	Aromatic, pungent and somewhat astringent	Aromatic and distinctly mucilaginous
Starch grains	Abundant, mostly over 0.010 mm.	Few, mostly under 0.010 mm.	Abundant, mostly over 0.010 mm.	Few, usually under 0.010 mm.
Cork cells	Present	Absent	Few	Absent
Fibers and stone cells	Fewer as compared with others	Abundant	More than Saigon, less than Ceylon	Abundant
Calcium oxalate	Raphides	Raphides	Raphides	Tabular and prismatic crystals

The powdered cinnamon found in the grocery trade is frequently a blend of several kinds of cinnamon. The blending is done either to improve the aromatic quality or to cheapen the product.

Aromatic Powder (U. S. P. 1820 to 1926; N. F. 1926 to date) is a mixture of cinnamon, 35 parts; ginger 35 parts; cardamom seed, 15 parts, and myristica 15 parts; reduced to fine powders and intimately mixed.

DESCRIPTION.—Moderate yellowish brown, with a strong, distinctive, aromatic odor, ginger starch grains numerous, ellipsoidal or ovoid, slightly beaked, and up to 60 microns in diameter; occasional stone cells; a few short calcium ...ous yellow-

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USES AND DOSE.—Aromatic stimulant and astringe...
and anodyne externally as a fomentation. Dose, 1 gm.

Cinnamon Oil or Cassia Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the leaves and twigs of *Cinnamomum Cassia* (Nees) Nees ex Blume, rectified by distillation.

Description.—Cinnamon Oil is a yellowish or brownish liquid becoming darker and thicker by age or by exposure to air, and possessing the characteristic odor and taste of cassia cinnamon, specific gravity, 1.045 to 1.063 at 25° C., refractive index, 1.6020 to 1.6135 at 20° C., optical rotation, +1° to −1° in a 100 mm. tube at 25°.

Constituents.—The principal constituent of the oil is cinnamic aldehyde, 75 to 85 per cent, the balance of the oil consisting of terpenes and other compounds.

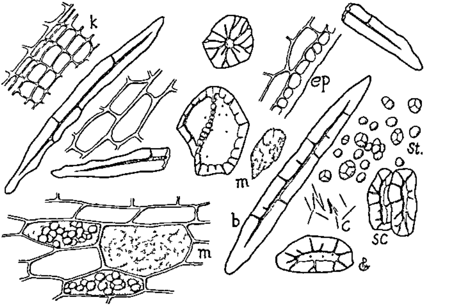

Fig. 144.—Powdered Cinnamon. *k*, fragment of cork, the cell walls somewhat lignified; *ep*, fragment of epidermis and parenchyma, the cuticle very thick and the parenchyma cell walls more or less brown, the cells containing an amorphous brown substance, starch,

by Paul D. Carpenter.)

To demonstrate cinnamic aldehyde in powdered cinnamon or in cinnamon oil, extract a few milligrams of the powder with about 1 cc. of chloroform, or dissolve a small drop of oil in 1 cc. of chloroform. Allow 2 drops of the chloroformic solu

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rosin oil, heavy metals or *chlorinated products*, the detection of all of which are described in the Pharmacopœia.

Uses and Dose.—Oil of cinnamon is used as a flavoring agent, a carminative and pungent aromatic. It also has antiseptic properties. Average dose, 0.1 cc.

Cinnamaldehyde, **Cinnamic Aldehyde or Cinnamyl Aldehyde** (U. S. P. 1905 to 1916; N. F. 1947 to date) contains not less than 98 per cent of C_6H_5CHO.

Cinnamaldehyde is obtained from Cassia Oil or synthetically from a mixture of benzaldehyde and acetaldehyde by the action of sodium hydroxide.

Description.—It is a yellow, strongly refractive liquid with a cinnamon-like odor and an aromatic, burning taste. It forms a clear solution in 7 volumes of 60 per cent alcohol and is miscible with alcohol, chloroform, ether and fixed or volatile oils. Specific gravity at 25° C. is 1.048 to 1.052. Refractive index at 20° C. is 1.618 to 1.623.

It should be stored in well-filled, tight, light-resistant containers protected from excessive heat.

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The powder is characterized by numerous thick-walled, irregularly curved simple hairs; fragments of reticulate and scalariform tracheæ; and broad, blunt bast fibers. The odor is aromatic; taste pungent, aromatic and astringent. Cassia buds yield a volatile oil containing cinnamic aldehyde, which resembles that of cassia cinnamon.

Cayenne Cinnamon is the bark of cultivated plants of *Cinnamomum zeylanicum* grown in Guiana, Brazil and some of the islands of the West Indies. It is obtained from larger branches than that produced in Ceylon, and is said to be inferior to it in quality. It is a rare article.

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linalool and safrol, 15 to 20 per cent of a terpene, 1 per cent of eugenol and about 3 per cent of eugenol-methyl-ether.

Clove Bark, or Cassia Caryophyll

ophyllatum, a tree indigenous to Brazil

of 6 to 10 pieces of the scraped bark.

fracture short, with a circle of whitish stone cells near the

like; taste mucilaginous and aromatic, resembling that of cinnamon.

CAMPHOR

Camphor (U. S. P. 1820 to date) is a ketone obtained from *Cinnamomum Camphora* (Linné) Nees et Ebermaier (Natural Camphor); or produced synthetically (Synthetic Camphor). *Camphora* is from the Arabic *kafur*, meaning chalk. The plant is a large evergreen tree (see Fig. 145) indigenous to eastern Asia but naturalized in the Mediterranean region, Ceylon, Egypt, South Africa, Brazil, Jamaica, Florida and California. Before World War II, about 80 per cent of the world's supply of natural camphor (about 4,000,000 kg. per year) was produced in Formosa, where the tree occurs naturally in abundance and is also extensively cultivated, the remaining 20 per cent being produced largely in Japan proper and southern China. Early references to camphor do not refer to the laurel camphor but rather to the Borneo camphor (see page 279) which reached Arabia in the sixth century and Europe in the twelfth. Laurel camphor appeared in Europe about the seventeenth century. On the Japanese annexation of Formosa, a government monopoly was created (1900). Since that time, however, the production of synthetic camphor has gradually lessened the demand for the Japanese product.

Natural camphor occurs as a crystalline product in clefts in the wood of the stems and roots, and to a greater extent dissolved in the volatile oil. The wood is chipped and distilled with steam, usually in a rather

crude way in a wooden tub with a perforated bottom over an iron kettle containing water and set in a masonry furnace. The steam passes through the tub filled with chips, conveys the camphor and volatile oil into the condensing tubs About twelve hours are required to distil a charge, and 1 pound of crude camphor is obtained from 20 to 40 pounds of chips. The crude camphor is then freed of oil by centrifugation and pressing, and finally resublimed in chambers where it condenses in small crystals

Fig 145 —*Cinnamomum camphora.* (After Köhler)

which are pressed into the familiar cakes. The crude camphor was formerly sent to Europe or America for refining, but since 1900 a considerable amount of the refining has been done in Japan.

Before World War II, about 6,500,000 kg. of synthetic camphor were produced annually in Europe and United States. During this war the production of synthetic camphor has been so increased as practically to replace natural camphor. With the conclusion of this war, and the restoration of Formosa to China, the production of natural camphor

probably will be resumed, but whether it will largely replace the synthetic camphor remains a question.

Synthetic camphor is made from pinene, the principal constituent of turpentine oil. A number of methods have been used for producing synthetic camphor, rather highly complex chemically, but all based on: (1) converting pinene into bornyl esters, which are (2) hydrolyzed to isoborneol, and (3) this is oxidized to camphor.

DESCRIPTION, CONSTANTS, AND TESTS OF IDENTITY AND PURITY.—See the

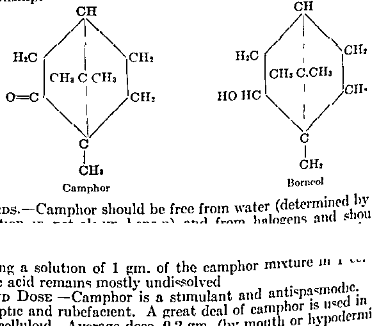
or pyrogallol, or resorincol, or thymol.

Camphor is readily pulverizable in the presence of a little alcohol, ether or chloroform. On heating some of the powder on a slide and covering with a watch crystal, a sublimate is obtained, composed of radiating aggregates of feather-shaped crystals, which are isotropic. A drop of a solution of vanillin (1 in 100) and a drop of sulfuric acid added to powdered natural camphor produces immediately a yellow color, changing to red, then violet and finally blue. Synthetic camphor gives no reaction.

The specific rotation of natural camphor (see U. S. P.) is between +41° and +43°. The specific rotation of synthetic camphor is between +5° and −5°.

CONSTITUENTS.—Camphor consists almost entirely of a dextrogyrate modification of the saturated ketone, $C_9H_{16}CO$.

The structural formulas of both camphor and borneol are given to illustrate their relationship.



Camphor Borneol

STANDARDS.—Camphor should be free from water (determined by the clarity

by preparing a solution of 1 gm. of the camphor mixture in 1 cc.

The stearic acid remains mostly undissolved

USES AND DOSE.—Camphor is a stimulant and antispasmodic. Externally it is antiseptic and rubefacient. A great deal of camphor is used in the manufacture of celluloid. Average dose, 0.2 gm. (by mouth or hypodermically).

Monobromated Camphor (U. S. P. 1882 to 1926; N. F. 1936 to date) is made by the action of bromine on camphor; it is composed of camphor about 65 per cent and bromine 35 per cent.

DESCRIPTION.—Colorless or prismatic needles or scales, with a mild, camphoraceous odor and taste; readily soluble in alcohol, chloroform or ether; nearly insoluble in water, melting point 74° to 76° C.

Uses and Dose.—It is a nerve sedative and an anaphrodisiac Dose, 0.125 gm

Camphor Oil, Formosa, Japanese, White or Light Oil of Camphor (U. S. P. 1863 to 1882) is the volatile oil from *Cinnamomum Camphora*.

Camphor Oil is a colorless or yellowish liquid, with an odor of camphor; it is insoluble in water, but readily soluble in 3 volumes of alcohol and in ether, chloroform and oils.

Camphor Oil consists largely of safrol; that portion of the oil boiling near 230° C. is separated as **Artificial Oil of Sassafras.**

Camphor Oil is a stimulant, rubefacient, antiseptic and parasiticide

Borneo Camphor or Borneol (see formula above) is a product found in clefts of the wood of *Dryobalanops camphora* (Fam. *Dipterocarpaceæ*), a large tree indigenous to Borneo and Sumatra. The camphor is obtained by scraping the wood and not by distillation. It somewhat resembles true camphor, but is distinguished by being heavier than water, not volatilizing at ordinary temperatures, and having a somewhat pungent taste. It is a secondary alcohol and is converted by nitric acid into true camphor. It should also be stated that true camphor when treated with reducing agents is converted into Borneo camphor The latter is seldom seen in commerce on account of its high price.

Ngai Camphor is similar to true camphor and is obtained from *Blumea balsamifera* (Fam. *Compositæ*), a shrub growing in the Malay Peninsula. In California, camphor is produced from *Ramona stachyoides, Artemisia trifolium* and *Artemisia frigida,* all Composites

SASSAFRAS

Sassafras or Sassafras Bark (U. S P. 1820 to 1926; N F. 1926 to date) is the dried bark of the root of *Sassafras albidum* (Nuttall) Nees (*S. variifolium* [Salisbury] O. Kuntze).

The plant is a tree indigenous to eastern North America. In the north it is commonly shrubby but farther south it attains a height of 20 to 30 meters. The leaves vary in form and size even on the same plant, some being ovate and entire, others 2- or 3-lobed; they contain a citral volatile oil, hence are pleasantly aromatic, resembling lemon. The stem bark contains a combination of the citral oil of the leaves and the safrol oil of the root bark. The root bark is gathered early in the spring or late in the fall, deprived of the outer corky layer and dried. Most of the commercial supplies come from Virginia, Tennessee and Kentucky. Sassafras was used medicinally by the Seminole Indians in Florida long before Ponce de Leon set foot there in 1512. The records of De Soto's invasion of Florida in 1538 show no reference to the drug, the earliest detailed description being that of the Spanish physician Monardes (1574).

Description, Structure and Powder.—See Figure 146 and the National Formulary.

Constituents.—Volatile oil 5 to 9 per cent, and containing about 80 per cent of safrol, tannin about 6 per cent; a reddish brown altered tannin compound (sassafrid), about 9 per cent, resin and starch

Standards —Sassafras yields not less than 4 cc. of sassafras oil from each 100 gm. of drug; it contains not more than 4 per cent of adhering wood or other foreign matter; and yields not more than 5 per cent of acid-insoluble ash

Uses and Dose.—Sassafras is an aromatic, an alterative and a carminative. Average dose, 10 gm.

Sassafras Pith (U S P. 1831 to 1916, N F. 1916 to 1936) is the dried pith of *Sassafras varifolium* (Salisbury) O Kuntze. It is gathered late in autumn

and contains a mucilage which is not precipitated by alcohol. A decoction of the drug is used as a demulcent in eye lotions and in gastro-intestinal irritations.

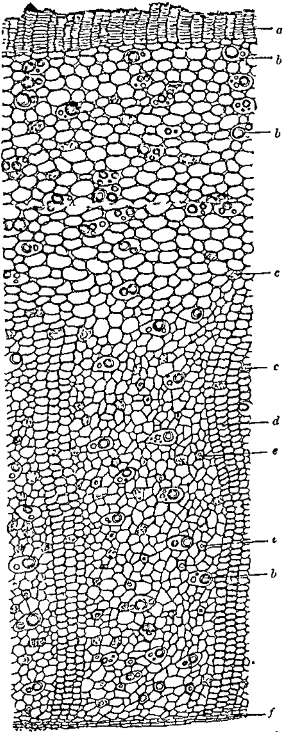


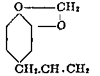
FIG. 146.—Transverse section of root bark of Sassafras· *a*, cork; *b*, oil cells; *c*, tannin cells; *d*, medullary rays, *e*, bast fibers, *f*, cambium. (After Bastin.)

Sassafras Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the root of *Sassafras albidum* (Nuttall) Nees. The oil is

distilled from the entire root rather than the root bark. Being heavier than water, it sinks to the bottom of the receiving vessel.

DESCRIPTION.—A yellow or reddish yellow liquid having the characteristic odor and taste of sassafras, specific gravity, 1.065 to 1.077 at 25° C.; optical rotation +2° to +4° in a 100 mm. tube at 25° C.; refractive index 1.525 to 1.535 at 20° C. Oil of sassafras should be free from heavy metals.

ires; if this occurs, carethen thoroughly mix it



It is abundant in camphor oil, from which it was first isolated in 1885, and in sassafras oil, it is also found in the volatile oil from the fruits of *Illicium religi-*

quid with the sassafras odor, boiling at 232°
11° C. It is insoluble in water, but readily soluble in alcohol, chloroform, ether, etc.

USES AND DOSE.—Sassafras Oil and Safrol are carminative and stimulant. Both are used as a flavoring in confections and pharmaceutical preparations, also in perfumery, especially for soaps. Average dose 0.1 cc.

Safrol may be readily converted into isosafrol, which upon oxidation, yields the aldehyde **piperonal (heliotropin)** used in perfumery (see page 188).

True Coto Bark is the bark of *Nectandra coto*, a tree growing in Bolivia. The bark occurs in flattened or curved pieces, from 7 to 20 mm. in thickness, the outer surface is reddish brown, nearly smooth or longitudinally fissured, occasionally with transverse clefts or grayish lichens, the smooth bark being marked

aromatic and pungent.

The bark contains a pale yellow volatile oil, having an aromatic odor and pungent taste; a light yellow crystalline glucoside, cotoin, 1.5 per cent, which is acrid and sternutatory, soluble in boiling water and alcohol, and which possesses the activity of the drug. Two new alkaloids have been isolated by Seil, a non-phenolic alkaloid, parosteminine and a phenolic alkaloid, parosteminine, the two making up about 1.38 per cent of the bark.

Coto is used as a tonic and stomachic, particularly in atonic dysenteries. Average dose, 1 gm.

acid and tannic acid.

False Coto Bark is obtained from *Ocotea pseudo-coto* (Fam. *Lauraceæ*) and from *Cryptocarya pretiosa* (Fam. *Sapotaceæ*), a tree growing in the Amazon district. It occurs in pieces about 15 cm. in length, 5 cm. in width and 7 mm. in thickness; externally light brown and without cork, fracture short, fibrous; internally brown with yellowish groups of stone cells, which are arranged in radial rows, thus distinguishing this bark from true coto bark. The odor is

slight, resembling that of cinnamon. It contains a brownish yellow volatile oil, with an odor suggestive of cinnamon, but it does not contain any cinnamic aldehyde. It also contains 0.145 per cent of an alkaloid.

Bay Laurel, the leaves and fruits of *Laurus nobilis*, are used as a spice.

PAPAVERACEÆ, OR POPPY FAMILY

This is a family of about 600 species, occurring most abundantly in north temperate regions. They are especially characterized by their milky and frequently yellowish latex, which arises either in laticiferous vessels or in special laticiferous sacs. The former are found in *Papaver*, and consist of tubes formed as a result of the fusion of cells in close proximity to each other, the dividing walls having become absorbed. The laticiferous sacs, which are present in *Chelidonium*, are either spheroidal or more or less cylindrical, elongated cells having very thin walls, and occur either isolated or arranged in longitudinal chains The tracheæ in this family are marked by simple pores. Calcium oxalate does not occur, except in *Bocconia*. Non-glandular hairs, when present, consist of a chain of cells. Glandular hairs have not been observed in this family.

OPIUM

Opium or Gum Opium (U. S. P. 1820 to date) is the air-dried, milky exudation obtained by incising the unripe capsules of *Papaver somniferum* Linné or its variety *album* DeCandolle. The term *opium* is from the Greek *opion*, meaning poppy juice; *papaver* is the Latin name for the poppy and *somniferum* is Latin meaning to produce sleep.

The opium poppy is an annual herb with large, showy, solitary flowers varying in color from white (var. *album*) to pink or purple. It is native to Asia Minor, was introduced into India by the Mohammedans in the fifteenth century and cultivation was begun in Macedonia and Persia about the middle of the nineteenth century. Opium is commercially produced now in Turkey, the Balkan States, Persia, India and China. The discovery of the medicinal qualities of opium is lost in antiquity. Theophastus (third century B.C.) mentions it, and Dioscorides (A D. 77) distinguishes between the juice of the poppy and an extract of the entire plant In 1806 Sertüner first isolated the alkaloid morphine from opium.

CULTIVATION, COLLECTION AND COMMERCE.—The seeds of the opium poppy are sown in October in well-cultivated soil The seeds germinate in the fall and the seedlings may be an inch high when snow falls; this protects them from freezing In the spring when the plants have attained the height of 6 inches, the fields are cultivated and the plants thinned to stand about 2 feet apart. The poppy blossoms in April or May and the capsules mature in June or July. Each plant bears from 5 to 8 capsules.

The ripening capsules, about 4 cm. in diameter, change from bluish green to yellowish in color This is a critical time for collecting the latex The capsules are incised with a knife, usually three-bladed, the incision being made around the circumference of the capsule The latex tubes open into one another so that it is not necessary to incise them all. Great skill, however, is required so as not to cut through the endocarp, in which case the latex would flow into

the interior of the [illegible] The latex, which is at first white, rapidly coagulates and [illegible] *early the following morning,* being scraped [illegible] a poppy leaf. When sufficient latex is collect[illegible] are wrapped in poppy leaves and shade dried. The opium is then inspected and usually packed with the brown winged fruits of a *Rumex* which prevents cohering. In some districts the latex is molded or pressed into cakes or other forms which are then wrapped in paper.

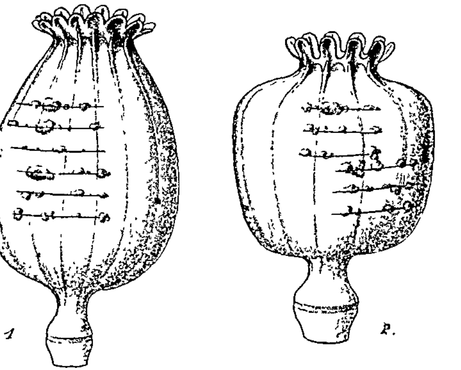


FIG. 147.—Poppy capsules grown in the gardens of the Pharmaceutical Institute of the University of Berlin in Dahlem, Germany. Two of the capsules grown from white seeds showing the transverse incisions from which the milk juice exudes, forming irregular *globular masses on the surface of the capsules.* (After Thoms.)

DESCRIPTION.—In more or l[illegible] about 8 to 15 cm in diameter [illegible] *of poppy leaves and at times* [illegible] the packing, more or less pl[illegible] tough on keeping, internally, [illegible] frequently interspersed with lighter areas, somewhat lustrous, odor characteristic, narcotic, taste very bitter, *characteristic.*

The principal commercial varieties are as follows [illegible]

[illegible] S. Pharma-[illegible] It is pro-[illegible]ipal ports of export being Constantinople and Smyrna. The term "Druggists' Opium" is often applied to Turkey opium containing from 10 to 20 per cent of moisture. "Soft" or "Shipping" opium are names applied to Turkish or Balkan opium having a pasty consistency and containing about 30 per cent of moisture. This grade has a high morphine content (10 to 21 per cent) and is imported for alkaloid manufacture. It never appears on the market for pharmaceutical purposes.

2. **Persian Opium** is rarely seen in the American market. It occurs in brick-shaped cakes having a more homogeneous texture than Turkey opium. When

dry it is extremely hard, due possibly to the addition of gum during its manufacture. It contains from 4 to 12 per cent of morphine. The cakes weigh about 500 gm. and are usually wrapped in red paper.

3. **Indian Opium** is produced at Ghazipur and is consumed in India or exported for British trade.
a kilo, or in balls w

4. **Chinese Opiu**
It occurs in flat globular cakes usually wrapped in paper and contains from 4 to 11 per cent of morphine.

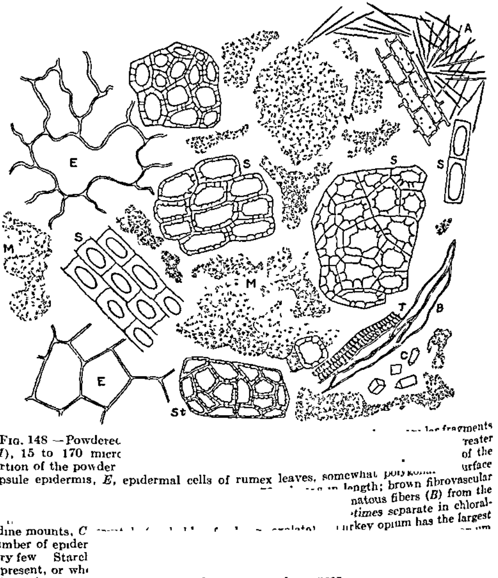


FIG. 148 —Powderec ... lar fragments
(*M*), 15 to 170 micrc ... reater
portion of the powder ... of the
capsule epidermis, *E*, epidermal cells of rumex leaves, somewhat polygonal ... urface
... length; brown fibrovascular
natous fibers (*B*) from the
times separate in chloral-
iodine mounts, *C* ... oxalate) ... Turkey opium has the largest
number of epider
very few Starcl
is present, or wh
Other microscopic characteristics of diluents may also appear.

5 ***Egyptian Opium*** *was formerly an article of commerce* Egypt has however discontinued the production of opium.

-lkaloids have been obtained from
no doubt, alteration products of the
the most important of these is mor-
per cent.
it of **meconic acid**, which exists free
nd other alkaloids. It forms rhombic

prisms, which are soluble in water and alcohol and give a deep red color in solutions of ferric chloride, which is not altered on the addition of diluted hydrochloric acid.
used for the detecti
cent, with about 0.

STANDARDS.—Opium in its normal, air-dried condition yields not less than 9.5 per cent of anhydrous morphine.

USES AND DOSE.—Opium acts chiefly upon the central nervous system, its

stances, as clay, sand, stone, lead piping, lead bullets, etc., have been found in opium. While starch is not usually admixed with Turkish opium, it is nearly always present in the Persian variety.

Granulated Opium (U. S. P. 1905 to date) and **Powdered Opium** (U. S. P. 1882 to date) yield not less than 10 per cent and not more than 10.5 per cent of anhydrous morphine. Granulated opium or powdered opium of a higher morphine percentage may be reduced to the officia
of a lower
extracts
color of the drug.

Granulated opium is used in making Tincture of Opium, and powdered opium in Dover's Powder.

considered as a highly narcotic alkaloid of opium but now considered non-narcotic. The drug meets the standards of powdered opium

Ipecac and Opium Powder or Dover's Powder (U. S. P. 1820 to 1942, N. F. 1942 to date) consists of finely powdered ipecac, 10 parts, powdered opium 10 parts, and coarsely powdered lactose 80 parts. These are triturated together until the mixture is reduced to a very fine powder.

DESCRIPTION.—The powder is very pale brown and consists mostly of coarse, angular, sometimes cone-shaped, colorless fragments, up to 400 microns in

sules, with their light brown, porous and strongly lignified walls, and other elements found in powdered opium, including tissues of the permissible diluents Lactose may further be identified by its phenylosazone (see page 131), and opium by the ferric chloride test for meconic acid

USES AND DOSE.—Ipecac and opium powder is a diaphoretic Opium augments the effect of ipecac by dilating the vessels of the skin. Average dose, 0.3 gm.

Papaver, or Poppy Capsules (U S P. 1842 to 1882, N. F 1916 to 1926) are the dried, full-grown, unripe fruits of *Papaver somniferum* or its variety *album*. The capsules are gathered in July, when they are full grown but still green and contain their milky juice. They are carefully and rapidly dried over a low-

burning fire. The capsules are ellipsoidal, ovoid or depressed globular (see Fig 147), from 6 to 7 cm. in length and from 4 to 7 cm. in diameter; very light, each weighing from 3 to 4 gm.; summit crowne[illegible] base usually tapering into the stalk; externally often marked with bluish black patches and sepiments; unilocular, and containing numerous seeds; inner surface with numerous, thin, cartilaginous dissepiments, about 10 mm. in width, of a light yellowish brown color and marked by numerous small, circular, brownish [illegible] bitter and slightly [illegible] cent of a mixture [illegible] alkaloids During [illegible] tage of codeine and [illegible] doses of 1 gm.

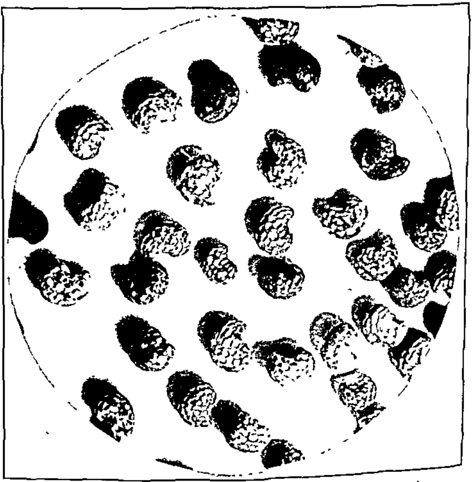


FIG 149 —Black Poppy Seed in lens view. (Photo by Adamson.)

Poppy Seed or Maw Seed is the dried seed of *Papaver somniferum* The seeds are bluish black or yellowish white, reniform (see Fig. 149), from 0.5 to 1 mm. in diameter, reticulate, with a yellowish hilum scar, white, oily endosperm and a curved embryo; taste slight and oily. Poppy seed are used in baking (poppy seed rolls). They contain about 50 per cent of a fixed oil (**Poppy Seed Oil**), which is used by artists as a drying oil, and also for food and salad dressings. ***Poppy Seed Oil Cake*** is used as a cattle food. Poppy seed contains no alkaloids.

Papaver Rhœas consists of the petals of the field poppy, *P. rhœas*. They are employed in Europe as a red coloring agent, the coloring material being an anthocyanin glucoside.

THE ALKALOIDS OF OPIUM

Morphine, U. S. P. 1831 to 1926
Morphine Acetate, U. S. P. 1831 to 1916.
Morphine Hydrochloride, U. S. P. 1842 to 1936; N. F. 1936 to date
Morphine Sulfate, U. S. P. 1831 to date.
Codeine, U. S. P. 1882 to 1947; N. F. 1947 to date.
Codeine Phosphate, U. S P. 1905 to date.
Codeine Sulfate, U. S P. 1905 to date
Ethylmorphine Hydrochloride, U S. P. 1916 to date.
Diacetylmorphine (Heroin), U. S. P. 1916 to 1926.
Diacetylmorphine Hydrochloride, U. S. P 1916 to 1926.
Apomorphine Hydrochloride, U. S. P 1882 to date.
Papaverine Hydrochloride, N. F. 1936 to 1947; U. S. P. 1947 to date
Cotarnine Chloride, U. S. P. 1916 to 1936, N. F. 1936 to date.
Dihydromorphinone Hydrochloride, U. S. P 1942 to date.
Narcotine, Thebaine, Narceine, Protopine, Codamine, Cryptopine, Gnostopine, Lanthopine, Laudanine, Laudanosine, Meconine, Meconodine, and Xantholine have never been recognized in the U S Pharmacopœia or the National Formulary.

Morphine is the most important of the opium alkaloids Morphine and the related alkaloids contain a phenanthrene nucleus and the various structural formulas which have been proposed are based on this fact. The molecule contains a phenolic and an alcoholic hydroxyl group

Morphine and its salts occur as white, silky crystals, sometimes in cubical
h a bitter
alcoholic

For the properties and tests of identity of morphine and its salts see the U S Pharmacopœia and the National Formulary With Marme's reagent, morphine gives clusters of slender needles; with Wagner's reagent, large reddish brown plates; and with sodium carbonate, prisms of considerable size

Morphine and its salts are strongly analgesic, hypnotic and narcotic, but very weakly stimulant Their use tends to induce nausea, vomiting and constipation as well as habit-formation

Codeine is obtained from opium (0 2 to 0 7 per cent) or prepared from morphine by methylation Codeine is methyl morphine, in which the methyl group replaces the hydrogen of the phenolic hydroxyl group The relation between morphine and codeine may be expressed as follows

$$C_{15}H_{14}ON\begin{cases}-OH\\ -CH\,OH\\ \quad|\\ -CH_2\end{cases}\qquad\qquad C_{15}H_{14}ON\begin{cases}-O\,CH_3\\ -CH\,OH\\ \quad|\\ -CH_2\end{cases}$$

Morphine — Codeine (Methyl morphine)

Codeine and its salts occur in fine needles or in a white crystalline powder which effloresce in air For other properties and tests of identity see the National Formulary and U. S Pharmacopœia.

Among the microcrystalline reactions for codeine. Marme's ... amorphous precipitate which ... these, upon standing, change ... gives long needles; chromic a... reagent, rosettes of plates; and ammonium thiocyanate, large rosettes of rods ... of plates; Wagner's with forked ends, which polarize brightly.

Codeine and its salts are used as sedatives especially in allaying coughs. While the action is similar to that of morphine, codeine is considerably less toxic and involves much less danger from habit formation. Average dose of codeine or its salts, 30 mg.

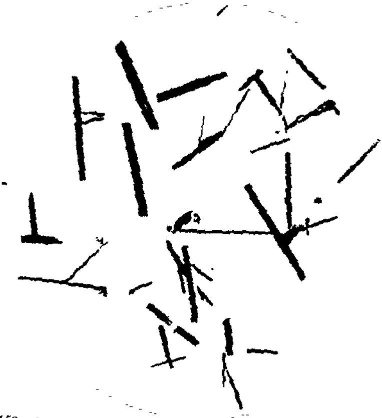


FIG 150.—Morphine sulfate: orthorhombic crystals from aqueous solution.

Ethylmorphine Hydrochloride is ... ether of morphine. It is prepared by treati... solution. The compound is ... phenolic g...

Ethylm... an ethyl group ... pounds (c... the U. S. Pharmacopœia for structure, tests, etc.). ... morphine, codeine and ammonium com-

The action of ethylmorphine is similar to that of morphine, except that it is less toxic and usually produces no constipation, nausea or lassitude. Average dose, 15 mg.

Diacetylmorphine or Heroin is formed by the acetylization of morphine, the hydrogen atoms of both the phenolic and alcoholic hydroxyl groups are replaced by acetyl groups. Heroin has a similar, but more pronounced action than morphine. Due to its potency and the danger from habit-formation, its manufacture in the United States is forbidden by law and its use has been practically discontinued

Apomorphine Hydrochloride.—When morphine is treated with hydrochloric acid in a sealed tube, one molecule of water is lost with the formation of apo-

...ly and must be
ken with distilled
tests, etc.)
ticularly valuable
as it may be administered subcutaneously in instances of poisoning. Average dose: expectorant, 1 mg.; emetic, by hypodermic injection, 5 mg.

Papaverine occurs naturally in opium to the extent of about 1 per cent. **Papaverine Hydrochloride** is in white crystals or as a white crystalline powder. It is odorless but has a slightly bitter taste. For other properties and tests of identity see the U. S. Pharmacopœia.

FIG. 151.—Codeine sulfate: orthorhombic crystals from hot alcoholic solution.

Papaverine Hydrochloride is a vasodilator and antispasmodic, and is used particularly in combination with codeine to abort "common colds." Average dose, 60 mg.

Cotarnine Chloride is a yellow, odorless crystalline powder, deliquescent in moist air (see the National Formulary for properties and tests).

It is a uterine and local hemostatic, often sold under the name of **Stypticin.** Average dose, 60 mg.

the presence of a catalyst

mc

cat

forming. Average dose: as a sedative and analgesic 2 mg.; for cough 1 mg.

Narcotine exists in opium as a free base (1.3 to 10 per cent) (see Fig. 152).

$$\underset{\text{Narcotine}}{C_{22}H_{23}O_7N} + O \rightarrow \underset{\text{Cotarnine}}{C_{12}H_{13}O_3N} + \underset{\text{Opianic acid}}{C_{10}H_{10}O_5}$$

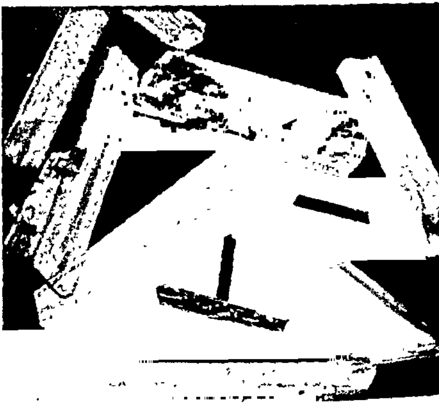


FIG. 152.—*Narcotine*: orthorhombic crystals from alcoholic solution.

Thebaine is dimethyl *morphine*. It occurs to the extent of 0.15 to 1 per cent in opium. It crystallizes in prisms which are insoluble in water or alkaline solutions but soluble in alcohol, and give with sulfuric acid a deep red color.

Narceine (0.1 to 0.7 per cent) occurs in silky needles or quadrangular prisms, which are nearly insoluble in cold water and alcohol, and are colored blue with iodine solutions and blood-red with chlorine water and ammonia.

SANGUINARIA

Sanguinaria or **Bloodroot** (U. S. P. 1820 to 1926; N. F. 1926 to date) is the dried rhizome of *Sanguinaria canadensis* Linné. The generic name is from *sanguinarius*, meaning bloody, and referring to the color of the juice; *canadensis* refers to the plant habitat in Canada. The plant is a low perennial herb (see Fig. 153), with a horizontal branching rhizome bearing slender roots, and containing an orange red latex. The rhizomes are dug during the early summer, deprived of their roots and carefully dried. It grows in rich open woodlands in North America east of the Mississippi, most of the collection taking place in the eastern

states. Bloodroot was used by the Indians for staining their faces, and also as an acrid emetic. Its use in home-made cough remedies seems to have been adopted by the early settlers.

DESCRIPTION AND STRUCTURE.—See Figure 154 and the National Formulary.

POWDER.—Sternutatory; taste bitter and persistently acrid; starch grains numerous, 3 to 20 microns in diameter, mostly single, and nearly spheroidal or

FIG. 153.—A group of transplanted blood root plants (*Sanguinaria canadensis*) showing 1-flowered scapes, and the palmately veined and lobed leaves.

CONSTITU[illegible] about 1 per [illegible] alkaloids are [illegible] salts with [illegible] mochelidonines in chelidonium [illegible] al organic acids, as citric and [illegible] 4.75 per cent with about 0.27

All of the alkaloids of sanguinaria are found in other members of the *Papaveraceæ* and, like berberine and hydrastine, are isoquinoline derivatives. While morphine and codeine are not isoquinoline derivatives they can be converted into isoquinoline alkaloids. It is interesting to note that the *Ranunculaceæ*, *Berberidaceæ*, *Menispermaceæ* and *Papaveraceæ* contain alkaloids of this type.

STANDARDS.—*Sanguinaria contains not more than 5 per cent of the roots of* the plant. Shriveled rhizomes that are gray internally and free from starch should be rejected.

USES AND DOSE.—Sanguinaria is a stimulating expectorant and an emetic. Average dose, 125 mg.

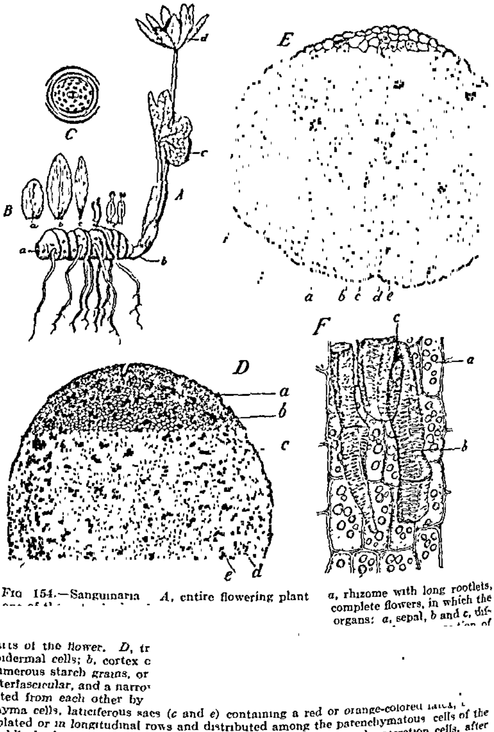


FIG 154.—Sanguinaria A, entire flowering plant a, rhizome with long rootlets, b ... complete flowers, in which the organs: a, sepal, b and c, dif-... parts of the flower. D, tr... epidermal cells; b, cortex c... numerous starch grains, or... interfascicular, and a narro... rated from each other by... chyma cells, laticiferous sacs (c and e) containing a red or orange-colored latex, ... isolated or in longitudinal rows and distributed among the parenchymatous cells of the middle bark and ... cells, after twenty-four hours, ... E, transverse section ... rred k, layer of epidern... sacs, b, endodermis, c, t... very ... one small starch grains, e, leptome. F, longitudinal section through tracheal ... of the vascular bundles of the rhizome a, starch-bearing parenchyma; b, scalariform tracheæ. (After Bastin.)

Chelidonium, or Celandine (U. S. P. 1882 to 1905) is the flowering plant of *Chelidonium majus*, a perennial herb having a milky, orange colored juice, and common in waste places in the northeastern United States and Canada. The drug should be collected at the time of flowering and used in a nearly fresh condition, as the active principles are partially destroyed and diminished on drying.

The powdered dried drug is light green, forming golden-yellow aqueous solutions, it contains seeds composed of nearly cubical thin-walled cells; non-glandular hairs, uniseriate, composed of 6 to 8 long cylindrical cells, some of which are collapsed and somewhat enlarged or swollen at their dividing walls, fragments of leaves with elliptical or spherical stomata on lower surface only,

Fig. 155.—Celandine (*Chelidonium majus*), a biennial or perennial herb, with pinnately divided leaves, and terminal clusters of small, yellow flowers. The plant has an orange-colored latex. (After Brown.)

and calcium oxalate crystals are wanting.

The drug contains 5 or more alkaloids: chelidonine (stylophorine), 0.03 per cent, in colorless monoclinic prisms; chelerythrine, which is fluorescent; α-, β-

and γ-homochelidonine and protopine. These several alkaloids are combined with the following acids: chelidonic, malic, citric and tartaric. It also contains chelidoxanthin, a bitter neutral principle, possessing a yellow color and resembling berberine; and a small quantity of a volatile oil. Another alkaloid, chelilysine, is said to disappear in the drying of the drug. Total ash about 6.5 per cent, with about 0.35 per cent of acid-insoluble ash.

Chelidonium is a sedative, a purgative, also a diuretic, a diaphoretic and expectorant. Average dose, 2 gm.

FUMARIACEÆ, OR FUMITORY FAMILY

This family consists mostly of delicate herbs and a few green shrubs. The leaves are usually compound and the flowers irregular, one or both of the petals having a spurred or a saccate base. The fruit is a unilocular capsule containing one or more seeds. The members of this family are characterized by having special secretion cells termed idioblasts, which are more or less elongated cells, varying from 2 to 10 mm. in length, and occur in the leaves as well as in the axis of the plant.

Corydalis, Turkey Corn, or Squirrel Corn (N. F. 1916 to 1947) consists of the dried tuber of *Dicentra canadensis* (Goldie) Walpers, or of *Dicentra cucullaria* (Linné) Bernhardi. The plants are low, stemless, perennial herbs, common in rich woods in the eastern and central United States and Canada. They have ternately compound and dissected leaves and form racemes of characteristic flowers having heart-shaped spurred corollas, those of *D. canadensis* being tinged with purple, while those of *D. cucullaria* are yellow at the summit.

The tubers of *D canadensis* are rounded, frequently depressed, and from 5 to 15 mm. in diameter, usually single; externally minutely pitted or nearly smooth, grayish brown or amber-colored and more or less translucent, with a triangular scar on one side and numerous fine roots on the other; fracture either hard and horny (the inner surface being yellowish and waxy), or somewhat tough (the fractured surface being yellowish-white and granular); odor slight; taste bitter.

The bulbils of *D cucullaria* are the thickened, tuberous bases of the leaves attached to a small upright rhizome, from which they easily separate; they are plump, ovoid or triangular-ovoid, up to 12 mm in length; externally yellowish or grayish brown, usually translucent; fracture hard and horny, the inner surface being grayish and waxy or granular.

The powder is pale brown to weak yellow; nearly odorless; slightly bitter taste; starch grains numerous, mostly single or 2-compound, from 3 to 60, rarely 90, microns in length, ovoid or oblong; tracheæ few, with simple pores, or reticulate, annular or spiral markings; epidermal cells with thin brownish walls, sclerotic cells irregular in outline, mostly elongated, up to 750 microns long and 150 microns wide with heavily lignified walls about 20 microns in thickness; rosette aggregates of calcium oxalate few and up to 20 microns in diameter.

Corydalis contains several alkaloids, of which protopine (fumarine) and corydaline are the most important; fumaric acid, a yellow bitter principle, resin and starch. Total ash 3 to 4 per cent; acid-insoluble ash, about 0 21 per cent.

Corydalis has been used in the treatment of syphilis. It is said to be tonic and alterative Average dose, 0 6 gm

CRUCIFERÆ, OR MUSTARD FAMILY

The plants are mostly herbs, occasionally woody, and include about 200 genera and 2000 species, which are widely distributed. The flowers

consist of 4 sepals, 4 petals, 6 tetradynamous stamens and a single compound pistil, becoming in fruit usually a 2-locular silique or silicle. They are especially characterized by their colorless secretion cells located in the parenchyma of the plant. They are stained by the anilin dyes; with solutions of orcin or orcein and hydrochloric acid they are colored violet; with Millon's reagent, the contents are precipitated and colored

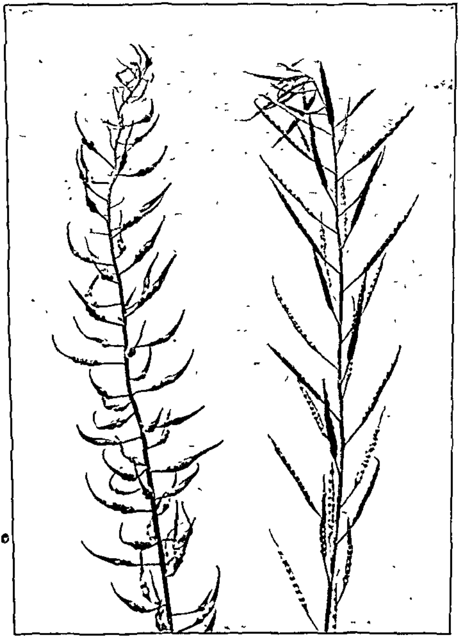


FIG. 156.—Fruiting specimens of the two mustards, the one on the left White Mustard (*Brassica alba*), and the one on the right Black Mustard (*Brassica nigra*). (After Newcomb.)

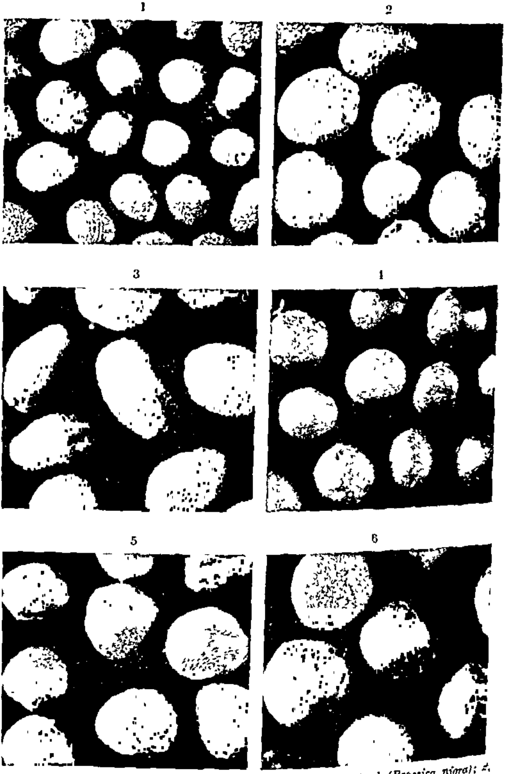


FIG. 157 — Commercial Brown Mustards *1*, Trieste Mustard (*Brassica nigra*); *2*, Indian Mustard (*B. juncea*), *3*, Sarepta Mustard (*B. besseriana*); *4*, Charlock (*B. arvensis*), *5*, Rape seed (*B. Napus*); *6*, Cabbage seed (*B. oleracea*) (Photos by Paul D Carpenter)

7 8 9 10 11 12

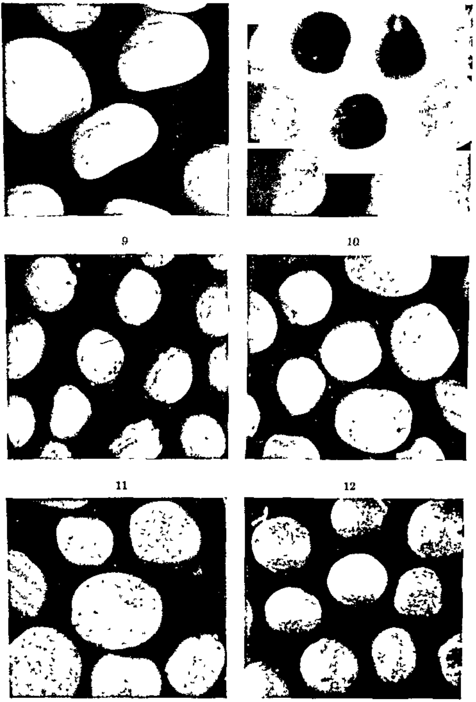


FIG. 158.—Commercial [illegible] *earson*). *8*, Chinese Colza [illegible] *10*, Yellow (White) Must[illegible] German Rape (*Brassica* [illegible] Paul D. Carpenter.)

red. In alcoholic material the contents of the secretion cells are precipitated and their position more readily determined. Myrosin-secreting cells occur in nearly all of the *Cruciferæ*, with the exception of *Capsella*, *Lepidium*, *Cakile*, and a few others. In the epidermis of the leaves of the *Cruciferæ* occur large water-storage cells readily distinguished by their greater size. The non-glandular hairs are unicellular and of various characteristic shapes for the different genera. Glandular hairs are seldom found, and calcium oxalate is wanting.

MUSTARD

Black Mustard or Brown Mustard (U. S. P. 1820 to date) is the dried ripe seed of *Brassica nigra* (Linné) Koch or of *Brassica juncea* (Linné) Czerniaew or of varieties of these species. The term *Cruciferæ* is from the Latin, meaning cross-bearing, and refers to the shape of the flowers, the petals of which are arranged in the form of a Maltese cross; *sinapis* is from the Celtic *nap*, meaning turnip; *Brassica* is from the Celtic *bresic*, meaning cabbage; *juncea* is Latin, meaning rush or reed; and *nigra* is Latin, meaning black. The term *mustard* is from the Latin *must* and refers to the ancient custom of pounding the seeds with vinegar, then known as *must*.

The plants are annual herbs (see Fig. 156) having slender erect stems, yellow flowers, pinnatifid leaves, and somewhat four-sided siliques with short stalks. They are native to Europe and southwestern Asia but are naturalized and cultivated in temperate climates in many countries, and show considerable variations in form. *B. nigra* is widely [illegible] *B. juncea* is cultivated [illegible] U. S. Pharmacopœia only since 1926. Black Mustard is mentioned by Diocletian (300 A.D.) as a condiment and both Theophrastus and Pliny mention its use in medicine. During the Middle Ages it was esteemed as an accompaniment to salted meats. The popularity of mustard as a condiment has by no means diminished today. Besides the home production the United States imports about 15,000,000 pounds annually.

Description and Structure.—See Figures 157, 158, 159 and the U. S. Pharmacopœia.

Powder.—Light olive brown; consisting mostly of tissues of the embryo, the cells containing small aleurone grains and fixed oil, the latter forming in [illegible] exhibit- [illegible] 159). [illegible] facili- [illegible] tate powdering.

Constituents.—Black mustard contains fixed oil (30 to 35 per cent), mucilage and aleurone. Its principal constituent, however, is the glucoside sinigrin (potassium myronate), which is accompanied (probably in adjacent cells) by the enzyme myrosin. Upon the addition of water to the crushed or powdered seeds the myrosin brings about the hydrolysis of the sinigrin as follows:

$$\underset{\text{Sinigrin}}{\begin{matrix} O{-}SO_3OK \\ | \\ C{-}S{-}C_6H_{11}O_5 \\ | \\ N{-}C_3H_5 \end{matrix}} + \underset{\text{(Myrosin)}}{H_2O} \rightarrow \underset{\text{Allyl isothiocyanate (Mustard oil)}}{S{=}C{=}N{-}CH_2{-}CH{=}CH_2} + \underset{\text{Pot. acid sulfate}}{KHSO_4} + \underset{\text{Glucose}}{C_6H_{12}O_6}$$

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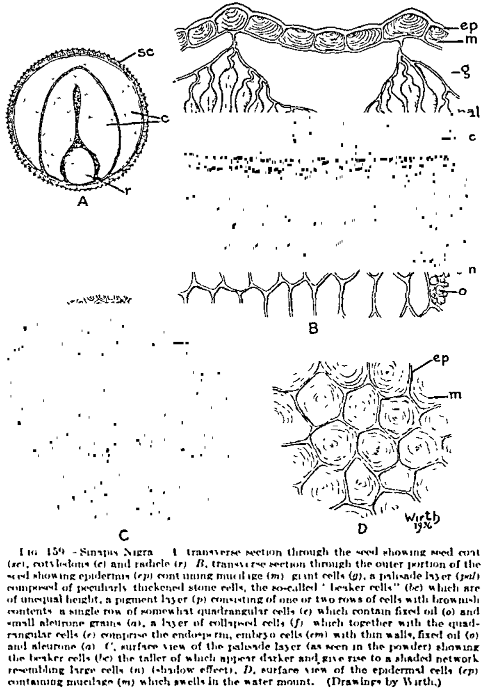


FIG. 159.—Sinapis Nigra. *A*, transverse section through the seed showing seed coat (*sc*), cotyledons (*c*) and radicle (*r*). *B*, transverse section through the outer portion of the seed showing epidermis (*ep*) containing mucilage (*m*), giant cells (*g*), a palisade layer (*pal*) composed of peculiarly thickened stone cells, the so-called "beaker cells" (*bc*) which are of unequal height, a pigment layer (*p*) consisting of one or two rows of cells with brownish contents, a single row of somewhat quadrangular cells (*c*) which contain fixed oil (*o*) and small aleurone grains (*a*), a layer of collapsed cells (*f*) which together with the quadrangular cells (*c*) comprise the endosperm, embryo cells (*em*) with thin walls, fixed oil (*o*) and aleurone (*a*). *C*, surface view of the palisade layer (as seen in the powder) showing the beaker cells (*bc*) the taller of which appear darker and give rise to a shaded network resembling large cells (*n*) (shadow effect). *D*, surface view of the epidermal cells (*ep*) containing mucilage (*m*) which swells in the water mount. (Drawings by Wirth.)

and the presence of impurities. Add a drop of silver nitrate to a drop of the thiosinamine solution: long needles, mostly
are formed. The latter reaction is quantita
mustard, the amount of allyl isothiocyanate
amount of silver nitrate used in reaction. T

$$\underset{\text{Allyl isothiocyanate}}{S{=}C{=}N{-}CH_2{-}CH{=}CH_2} + \underset{\text{Ammonia}}{NH_3} \rightarrow \underset{\text{Thiosinamine}}{S{=}\underset{\underset{NH_2}{|}}{C}{-}NH{-}CH_2{-}CH{=}CH_2}$$

$$S{=}\underset{\underset{NH_2}{|}}{C}{-}NH{-}CH_2{-}CH{=}CH_2 + 2AgNO_3 + NH_3 \rightarrow CN.NH\,CH_2{-}CH{=}CH_2 + 2NH_4NO_3 + Ag_2S$$

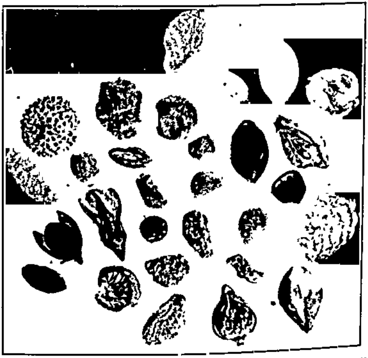


FIG. 160.—A mixture of fruits and seeds picked out from a commercial "Black" Mustard. The mustard is screened out from wheat, particularly in Minnesota and the Dakotas. Eleven different weed seeds or fruits are shown in the picture. (Photo by Paul D. Carpenter.)

The presence of sinigrin (which has an atom of potassium in the molecule)
... reactions for potassium
...ubtful value as an identity
...rces may give the reaction.
... 0.6 per cent of volatile oil
of mustard (calculated as allyl isothiocyanate) ...lack mustard contains not more than 5 per cent of other seeds (see Fig. 160) or other foreign organic matter (see Fig. 160).

USES AND DOSE.—Mustard is an emetic and condiment, and is used externally as a rubefacient and a vesicant. Average dose, emetic, 10 gm.

ADULTERANTS AND SUBSTITUTES.—The black mustard of commerce may be admixed with the seeds of **Wild Mustard or Charlock** (*Brassica arvensis*). This plant is very common in the wheat fields of the Northwestern States and the seeds are almost always present in the mustard from this territory. A product known as **Dakota Mustard** consists largely of the seeds of this plant. They are

become blood-red on heating with chloral T.S.

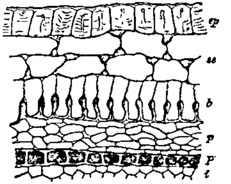


FIG. 161.—Transverse section of White Mustard ep, epidermis, sc, collenchyma, b,

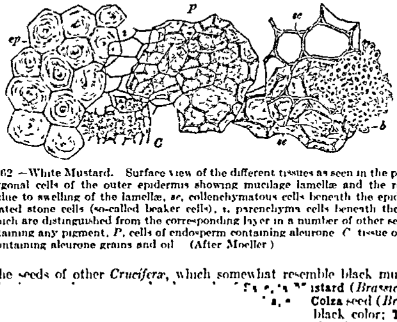


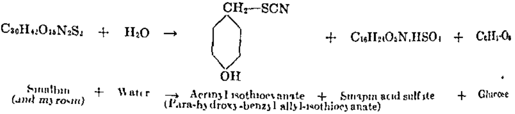
FIG. 162.—White Mustard. Surface view of the different tissues as seen in the powder *ep*, polygonal cells of the outer epidermis showing mucilage lamellæ and the reduced lumina due to swelling of the lamellæ, *sc*, collenchymatous cells beneath the epidermis, *b*, elongated stone cells (so-called beaker cells), *s*, parenchyma cells beneath the stone cells, which are distinguished from the corresponding layer in a number of other seeds by not containing any pigment, *P*, cells of endosperm containing aleurone *C* tissue of cotyledon containing aleurone grains and oil (After Moeller.)

Of the seeds of other *Cruciferæ*, which somewhat resemble black mustard, ... ustard (*Brassica bes-* ... **Colza** seed (*Brassica* ... black color; **Turnip** ... but less acrid, and

White Mustard, or Sinapis Alba (U. S. P. 1831 to 1926) consists of the dried ripe se... black ... consid ... 156).

Most of the commercial supplies come from California, Holland and England The seeds are subglobular, *from 1 to 3 mm.* in diameter; externally yellow to yellowish brown; minutely pitted, and showing a ridge and 2 grooves on one curved surface. The structure and powder are described in Figures 161 and 162, the essential differences from black mustard being the absence of pigment cells and the absence of the "shadow effect," the beaker cells being of equal height.

White mustard contains 20 to 25 per cent of fixed oil, mucilage, the ferment *myrosin* and a glucoside sinalbin which upon hydrolysis yields acrinyl isothiocyanate, a pungent tasting but almost odorless oil much less volatile than allyl isothiocyanate.



White mustard exhibits the same therapeutic action as black mustard In the manufacture of condiments it is customary to mix some of the white mustard with the black mustard, it being supposed that the excess of the ferment in white mustard will change ... into volatile oil of mustard. It ... product is due to the pun... mustard

A number of yellow or light brown cruciferous seeds have been imported as substitutes for white mustard, notably **Indian Colza** (*B. campestris* var. *sarson*), **Chinese Colza** (*B. chinensis*); **Japanese Mustard** (*B cernua*) and **Indian Tori** (*B glauca*) (see Fig 158).

Mustard Flour consists of the embryonic tissue of either or both black and white mustard, and may or may not contain fixed oil. It is usually prepared by grinding the cake from which the oil has been pressed. The resultant powder is then sifted to remove the "hulls" (*seed coats*), thus leaving the embryonic tissue together with the cell contents (aleurone, the glucosides and myrosin). Some mustard flours also contain considerable fixed oil. The principal adulterants of mustard flour are: (1) Mustard hulls which enter the product through ... by their histological ... flours or starches, ... stic starch grains, (3) curcuma which is added to color the product and which may be detected by the sulfuric acid-alcohol test or by its microscopic characteristics (see page 182); and (4) capsicum, which is added to increase the pungency and which may be detected by the presence of lignified wavy-walled stone cells (see page 570)

If seed-coat fragments are entirely wanting the presence of either black or ... yonic tissue ... micro- ... chemically Black mustard will yield allyl isothiocy... tion in water which may be determined by the methods outlined on page 300. White mustard contains sinalbin which will give a red color with Millon's reagent, a ... This latter test may be carried out ... water, allowing to stand half ... The petroleum ether is filtered ... and the residue then treated ... is produced, white mustard is present.

Prepared Mustard, German Mustard, French Mustard or Mustard Paste is

composed of a mixture of the powdered mustards or mustard flour with salt, vinegar, and with or without spices or other condiments which do not simulate the color of yellow ground mustard. Calculated free from water, fat, and salt, it contains not more than 24 per cent of carbohydrates (calculated as starch), not more than 12 per cent of crude fiber, not less than 5 6 per cent of nitrogen derived solely from the materials herein named (U. S Dept. Agric).

Allyl Isothiocyanate or Volatile Oil of Mustard (U. S. P. 1882 to 1947; N. F. 1947 to date) is the oil obtained by maceration with water and subsequent distillation of the dried ripe seed (free from the fixed oil) of *Brassica nigra* (Linné) Koch or of *Brassica juncea* (Linné) Czerniaew or prepared synthetically.

Volatile oil of mustard is usually prepared from the ground cake from which the fixed oil has been removed by expression. It is also prepared synthetically by the decomposition of allyl iodide with potassium sulfocyanate in alcoholic solution. The National Formulary requires the label to state whether the oil is prepared synthetically or distilled from either of the above-mentioned plants.

Description —A colorless or pale yellow, strongly refractive liquid having [illegible] *ild be exercised in* [illegible] *rd* (Consult the [illegible] per cent of allyl isothiocyanate.

Uses and Dose —Volatile oil of mustard is generally used externally as a rubefacient or vesicant Internally it is a gastro-intestinal irritant. Average dose, 0 008 cc

[illegible] 1820 to 1863) is the fresh root of [illegible] sinigrin and myrosin and, after [illegible] cent of a volatile oil containing [illegible] drug in place of mustard, and is extensively used as a condiment

DROSERACEÆ, OR SUNDEW FAMILY

This is a small family of biennial or perennial herbs including the Venus' fly-trap. The typical genus of the family, *Drosera*, possesses peculiarly stalked glands known as glandular tentacles, which secrete a sticky material by which insects are trapped and then secrete a digestive juice which destroys the insect caught within the rolled up leaf The dissolved proteins are absorbed by the plant as food

Drosera, or Sundew (N F 1916 to 1936) is the entire plant of *Drosera rotundifolia*, frequently mixed with the closely allied species *D anglica* and *D longifolia*, or at times wholly replaced by these The drug is more or less crumpled and matted; the leaves are petiolate, mostly basal, 7 to 15 mm in diameter, abruptly narrowed into the petioles and covered with numerous pinkish red glandular tenacles, about 4 mm in length

The drug contains a greenish brown resin, having a slight odor and a very acrid taste; an enzyme capable of converting albumin into peptone; also citric acid and probably malic acid Total ash about 4.25 per cent; acid-insoluble ash about 0.75 per cent.

Drosera is used as a pectoral. It has had some reputation as a remedy for whooping cough. Average dose, 4 gm.

SAXIFRAGACEÆ, OR SAXIFRAGE FAMILY

These are mostly perennial herbs, seldom annual plants or shrubs The family is represented by about 70 genera and 600 species which are mostly indigenous to the North Temperate zone. The fruit are especially characterized by having a small embryo embedded in a large endosperm. The tracheæ always possess scalariform perforations and the walls adjoining the parenchyma are usually marked by simple pores.

Hydrangea, or Seven Barks (N. F. 1916 to 1926) consists of the dried rhizome and roots of *Hydrangea arborescens*. The plant is a beautiful shrub growing wild along the rocky banks of streams throughout the central and southern United States.

The rhizome is cylindrical, usually in pieces 3 to 20 mm. in diameter; light brown to yellowish brown with a pinkish tinge; longitudinally wrinkled and marked by a few elliptical lenticels,
or stem-scars, while from the lower
fracture tough, splintery; internally
separable from the distinctly radiate wood.

Hydrangea has a corky layer consisting of several rows of grayish white tabular cells; a cortex consisting chiefly of starch-bearing parenchyma, large

gonal cells with prominent simple pores.

The powder is very pale orange in color, inodorous, and with a slightly sweet and acrid taste. It consists mostly of irregular fragments of the wood containing strongly lignified tracheæ, tracheids and medullary ray cells; stone cells 30 to 200 microns in length, strongly lignified; raphides numerous, 50 to 135 microns in length; starch grains mostly simple, ellipsoidal, occasionally with a prominent central cleft, and varying from 2 to 10 microns in diameter.

The drug contains the glucoside hydrangin, about 1 per cent, crystallizing in aggregates, soluble in alcohol and ether, and giving with solutions of the
the addition of
al ash, about

2 gm.
me and roots
of *Heuchera americana* Linné. The plant is a low perennial, the heart-shaped leaves mostly radical.

The rhizome may be up to 30 mm thick and is usually cut transversely into pieces. It is somewhat compressed, knotty and irregular; yellow or light brown in color, and very astringent in taste The dried drug contains from 10 to 20 per cent of tannin. It is used as an astringent both internally and externally. It has been largely replaced by tannic acid.

HAMAMELIDACEÆ, OR WITCHHAZEL FAMILY

This is a family consisting mostly of subtropical trees or shrubs and represented by 18 genera and 50 species. The non-glandular hairs are either stellate or tufted. Calcium oxalate is excreted either in the form of solitary crystals or rosette aggregates. Tannin-secretion cells are very characteristic in *Hamamelis*. Schizogenous resin canals in *Liquidambar* occur commonly at the margin of the pith and can be traced

into the finest branches of the veins of the leaves In roots they are associated with the development of primary and secondary phloem

STORAX

Storax or Liquid Storax is obtained from the trunk of *Liquidambar orientalis* Miller, known in commerce as Levant Storax (U. S. P. 1831 to date), or of *Liquidambar Styraciflua* Linné, known in commerce as American Storax (U. S. P 1926 to date). In the U. S Pharmacopœia from 1831 to 1863 Styrax is ascribed to *Styrax officinale* This plant does not yield Levant Storax as is pointed out in the U. S. Dispensatory of 1833.

The term *Styrax* is from the Arabian *assthrax*, meaning a sweet smelling exudation; *Liquidambar* is from the Latin *liquidus*, meaning fluid and the Arabian *ambar*, meaning amber; *orientalis* means pertaining to the Orient and *styraciflua* means to flow storax. *L. orientalis* is a tree attaining the height of about 15 meters and grows in Asia Minor. *L. styraciflua* is a tree attaining a height up to 40 meters and grows in southern North America, Central America and northern South America. Levant storax is a pathological product, its formation being induced by bruising or puncturing the bark of the tree in early summer, which causes the cambium to produce new wood with balsam-secreting ducts. In autumn, the bark which is more or less saturated with balsam, is peeled off and the balsam recovered by pressing. The bark is then boiled in hot water and again pressed. The balsam is poured into casks or cans and is usually exported via Smyrna. Most of the American storax is produced in Honduras where large forests of *L. Styraciflua* are found. The balsam exudes into natural pockets between the bark and the wood which may be located by excrescences on the outside of the bark. These pockets which contain up to 8 pounds of the balsam are tapped with gutters and the balsam led into containers The balsam is exported in tin cans. A small quantity is also produced in the United States. The early Arabian physicians were acquainted with storax and it is mentioned as early as the twelfth century.

DESCRIPTION Levant storax is a viscid, grayish to grayish brown, more or less opaque, semiliquid mass, depositing on standing a heavier, dark brown, oleoresinous stratum American storax is a nearly clear, yellowish brown semiliquid, becoming hard, opaque and darker colored Storax is transparent in thin layers, odor agreeable, taste balsamic

Storax is insoluble in water but almost completely soluble in warm alcohol; it is soluble in ether, carbon disulfide, benzol or acetone but insoluble in benzin.

CONSTITUENTS Levant storax consists of about 50 per cent of two resin [illegible] partly free, partly in combination [illegible] do not form a crystalline compound [illegible] storesin cinnamate, 10 to 20 per cent; styracin or cinnamyl cinnamate, 5 to [illegible] odorless and tasteless; phenyl- [illegible] and taste of styrax; volatile [illegible] acid from 2 to 5 per cent; and small amounts of several other substances Free cinnamic acid may be

obtained from storax by microsublimation (see page 484) with a yield up to 20 per cent.

American Storax contains related storesins and other items found in Levant storax. It yields 7 per cent of volatile oil by steam distillation; and contains about 28 per cent of cinnamic acid, 23 per cent of cinnamein, 35 per cent of resin esters and 2 per cent of resin acids.

STANDARDS.—Storax loses not more than 20 per cent of its weight upon drying at 100° C. for two hours, and not more than 5 per cent of residue remains after thorough extraction with boiling alcohol. The alcoholic solution upon drying yields a yellowish brown residue (not less than 70 per cent of the weight of storax taken) known as **Purified Storax** (U. S. P. 1831 to 1863). Purified storax yields not less than 25 per cent of cinnamic acid, and has an acid value of from 50 to 85 for Levant storax and from 38 to 85 for American storax. Its saponification value is not less than 160 and not more than 200. When the balsam is boiled with a solution of potassium permanganate and sulfuric acid it evolves an odor resembling that of bitter almonds (due to the presence of cinnamic acid); it forms little or no foam when mixed with an equal volume of alcohol and shaken with ammonia water, indicating the absence of turpentine and fixed oils. It should be free from rosin and rosin oils.

USES AND DOSE.—Storax is a stimulant, an expectorant and an antiseptic. Average dose, 1 gm.

Cinnamic Acid (C_6H_5.CH CH.COOH) was first obtained from cinnamon oil by Dumas in 1834. It is now commercially obtained from Peru balsam, Tolu balsam, storax or cinnamon oil, or is produced synthetically from benzaldehyde. It occurs in white crystals and forms salts with alkalis. The acid is readily soluble in alcohol and the usual organic solvents; sodium cinnamate is readily soluble in water.

Cinnamic acid and its salts cause leucocytosis and have been used medicinally for this purpose; also in tuberculosis of the lungs and skin, though the results have not been marke [illegible] the skin, a 5 per cent alcoholic solution is [illegible] enously, 10 mg.

ADULTERANTS.—L [illegible] adulterated with dirt and inorganic materials, other gums, resins and oils, etc. An entirely **factitious storax** has been prepared so as to resemble storax and is still a common article of commerce.

ALLIED PRODUCTS.—Storax is also obtained from *Altingia excelsa*, of the Indian Archipelago. This tree yields a soft, white, crystalline balsam, developing the fragrant odor of styrol and containing about 50 per cent of an ester of cinnamic acid. A brown, solid balsam is also obtained from it. This balsam has an odor of cinnamon and contains a trace of free cinnamic acid and 9.7 per cent of cinnamic acid in the form of an ester. The oil from this plant is known as **Rasamala wood oil**, and contains a ketone.

HAMAMELIS

Hamamelis Leaf or Witch Hazel Leaves (U. S. P. 1882 to 1916; N. F. 1916 to date) is the dried leaf of *Hamamelis virginiana* Linné.

Hamamelis Bark, or Witch Hazel Bark (U. S. P. 1905 to 1916) consists of the bark and twigs of *Hamamelis virginiana*.

Hamamelis is from the Greek *hama*, meaning "at the same time" and *melis* meaning "a fruit;" *virginiana* indicates that the plant is found in Virginia. The plant is a shrub or small tree attaining a height of 8 meters. The flowers appear in the fall at the same time as the ripening fruits from the previous year. The leaves or bark are collected in autumn and carefully dried, commercial supplies coming from Virginia,

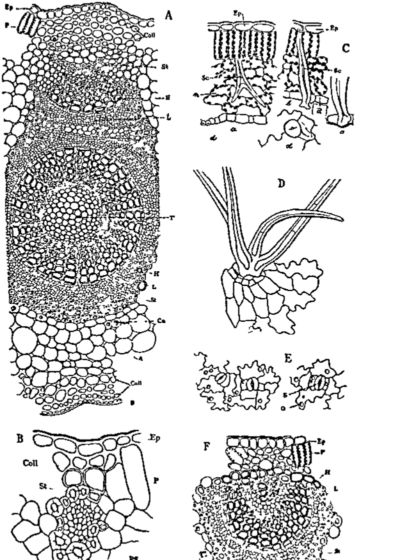


FIG. 163 —Hamamelis Leaf *A*, transverse section of a midrib from about middle of the leaf-blade, showing an arch-shaped collateral vascular bundle situated near the upper or ventral epidermis and a stele with a central pith (*T*) near the center of the section *Ep*, ventral epidermis, *Coll*, collenchyma, *P*, palisade cells, *St*, sclerenchymatous fibers, *H*, tracheæ, *L*, sieve, *T*, pith, *Ca*, calcium oxalate *A* colorless tissue *D*, dorsal epidermis. *B*, transverse section of a thin mesotome strand of leaf-blade *Ep*, ventral epidermis, *Coll*, collenchyma *P*, palisade tissue *St*, stone cells *PS*, parenchyma sheath *N*, loose mesophyll *C*, transverse section of leaf-blade *Ep*, ventral epidermis, *D*, dorsal epidermis, *Sc* colorless stone cells (also called idioblasts), *N* loose mesophyll, in figures *a* and *b* the palisade and pneumatic tissue are shown with thick-walled stone cells, branched in *a*, penetrating epidermis in *b* in *c* one end of a sclereid is entering an epidermal cell, and in *d* is shown a surface view of the epidermis with the end of a stone cell *D* basal portion of a 4-branched hair from the dorsal epidermis of leaf, showing very thin cross-walls in the branches *E*, surface view of dorsal epidermis of leaf-blade, showing the stomata (*S*) and oil globules (*O*) *F*, transverse section of a midrib from near the summit of the leaf-blade, letters as *A*. (After Holm.)

Tennessee and South Carolina. The decoction or infusion of witch-hazel leaves has been in common use from the days of the American Indian, whose use of the plant led the early settlers to its employment.

DESCRIPTION AND STRUCTURE.—Leaves and bark: see Figures 163 and 164 and the National Formulary.

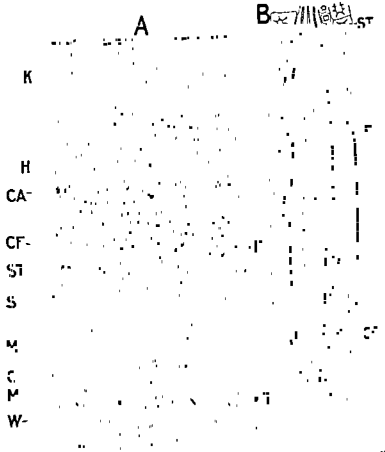


FIG. 164.—Hamamelis Bark. A, transverse section of twig. K, cork; H, cells of cortex; ... Ca, calcium ... gly ligni- ... tracheæ ... k-walled

B, tangential section of a twig showing stone cells (St), crystal fibers ..., bast fibers (F).

POWDER.—The powdered, recently dried leaves are dark green in color; after aging this powder is yellowish brown to light yellow with a slight odor and an astringent, slightly aromatic and bitter taste. The powdered bark exhibits masses of brownish or yellowish cork cells, some of them lignified; groups of parenchyma cells with tannin or small starch grains; strands of lignified bast-tracheæ with bordered pores; strongly lignified wood fibers with slit-like or ... monoclinic prisms of calcium oxalate, ... f shows numerous frag- ... having numerous ... length, ...

... bark contain a ... known as hamamelitannin which appears to be derived from gallic acid and a hexose sugar; a volatile oil; a bitter principle; gallic acid and calcium oxalate. Hama-

melin is an evaporated alcoholic extract of either the leaves or bark, that of the former being greenish black and more permanent.

Uses and Dose.—Both leaves and bark are astringent and hemostatic Average dose, 2 gm

Hamamelis Water or Distilled Extract of Witch Hazel (N. F. 1888 to 1905, 1926 to date, U. S. P. 1905 to 1926) *is prepared as follows:*

Macerate a weighed amount of the recently cut and partially dried dormant twigs of *Hamamelis virginiana* for about twenty-four hours in about twice their weight of water, then distil until not more than 850 cc. of distillate is obtained for each 1000 gm. of the twigs taken; add 150 cc. of alcohol to each 850 cc. of distillate, mix thoroughly.

De[illegible] character-
istic [illegible] or slightly
acid [illegible] *isopropyl*
alcohol

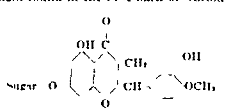
Constituents —Upon evaporation Hamamelis Water yields not more than 0 025 per cent of dry residue. Alcohol content from 14 to 15 per cent by volume, of C_2H_5OH. The identity of the aromatic volatile principle present is not [illegible] h hazel bark; it may be formed [illegible] y by rubbing or fomentation

GLYCOSIDES

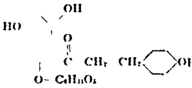
Glycosides are compounds which upon hydrolysis yield one or more sugars among the products of hydrolysis. The most frequently occurring sugar is β-glucose although rhamnose and other sugars are occasionally found as components of glycosides. Chemically the glycosides are acetals in which the hydroxyl of the sugar is condensed with an hydroxyl group of the non-sugar component and the secondary hydroxyl is condensed within the sugar molecule itself to form an oxide ring. More simply they may be considered as sugar ethers. The non-sugar component is known as the *aglycon* Using the chemical nature of the aglycon group as a basis of systematization the following classification of the more common glycosides may be devised:

1. **Phenol Group.**—The aglycon groups of many of the naturally occurring [illegible]

hizin found in the root bark of various rosaceous plants are phenol glycosides.



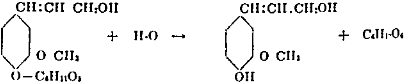
Hesperidin



Phlorhizin

Baptisin (page 358) from Baptisia and *iridin* (page 175) from *Iris* species are additional examples of phenol glycosides.

2. **Alcohol Group.**—*Salicin* whose hydrolysis into saligenin is illustrated on page 202 is an alcohol glycoside. Although saligenin has a phenolic hydroxy



Coniferin Coniferyl alcohol

Coniferyl alcohol (page 188) when oxidized with $K_2Cr_2O_7$ yields vanillin.

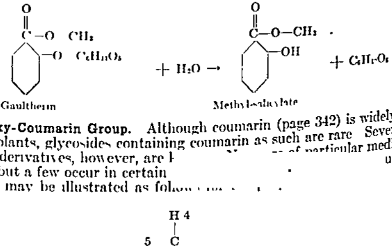
3. **Aldehyde Group.**—*Salinigrin* occurring in *Salix discolor*, consists of glucose combined with *m*-hydroxybenzaldehyde, thus representing a glycoside having an ... aldehyde

+

(p

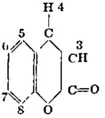
that may be classified in this group.

4. **Acid Glycosides.**—Jalap, Ipomœa and Scammony contain glycosides which upon hydrolysis yield resin acids (convolvulinic acid, jalapinolic acid, ipurolic acid). The sugar groups usually consist of rare sugars, d-fucose having been isolated from *jalapin* and d-isorhamnose, a methyl pentose from *convolvulin*. *Gaultherin*, although its aglycon is an ester of salicylic acid, might be classified as an acid glycoside. Gaultherin is found in sweet birch and wintergreen. The sugar present is primeverose



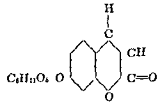
Gaultherin Methyl-salicylate

5. **The Oxy-Coumarin Group.** Although coumarin (page 342) is widely distributed in plants, glycosides containing coumarin as such are rare. Several of its hydroxy derivatives, however, are ... of particular medicinal importance but a few occur in certain ... ucture these of coumarin may be illustrated as fol... glycosides

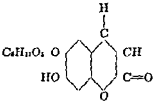


Skimmin occurs in Japanese Star-anise (page 264) and yields upon hydrolysis 7-hydroxy-coumarin or umbelliferone (page 475). *Æsculin* found in the bark of the horse-chestnut tree yields æsculetin, 6,7-dihydroxy-coumarin upon hydrolysis. *Daphnin* found in Mezereum and in *Gnida polycephala* yields daphnetin, 7,8-dihydroxy-coumarin. *Fraxin* found in the bark of several species of ash

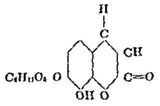
yields fraxetin, 6-methoxy-7,8-dihydroxy-coumarin. *Scopolin*, found in Bella- ... oumarin. *Limettin*



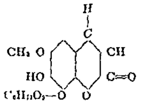
Skimmin



Æsculin

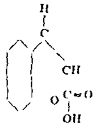


Daphnin



Fraxin

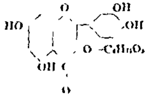
Melilotin from *Melilotus altissima* supposedly yields coumarin itself. Its structure is assumed to be as follows:



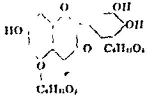
following types:

A *The Anthraquinones*, such as *alizarin*, from madder root.

B *The Flavones or Xanthones.*—Most of the yellow pigments found in plants are flavones such as *chrysin* (5,7-dihydroxy-flavone) from poplar bud, *apigenin* (5,7,4'-trihydroxy-flavone) from celery and parsley, *luteolin* (5,7,3',4'-tetrahydroxy-flavone) from *Reseda luteola* and *Genista tinctoria* and *quercetin* (3,5,7,3',4'-pentahydroxy-flavone) from *Quercus tinctorius*, the horse-chestnut, hops, etc.



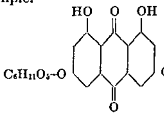
Quercitrin



Cyanin

C. *The Anthocyanins and Anthoxanthins*, which include most of the red, blue and violet pigments found in plants. Belonging to this group are *cyanin*, the blue pigment in the petals of *Centauria cyanus*, *idain* from cranberries, *pelargonin* from asters, dahlias and geraniums, *peonin* from peonies, *oenin* from blue grapes, *myrtillin* from the whortleberry, *delphinin* from delphiniums, and so on.

6. **The Anthraquinone Group.**—Closely related to Group A above are a number of glycosides occurring in such drugs as rhubarb, senna, frangula, cascara sagrada, aloe, rh
are usually di-,
416 and 418).
quinone) is a typical example.



Frangulin

These compounds give the Borntrager reaction (page 159) and may or may not account for the laxative action of these drugs. They are closely related to some of the red and yellov
for example, found in the
cules of glucose combined
The aglycon of this glycoside is alizarin and was one of the first organic dy
to be synthesized.

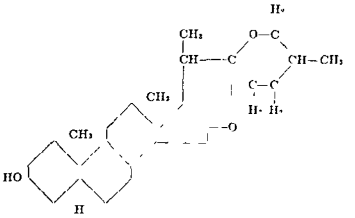
7. **The Cyanophore Group.**—Several glycosides yielding hydrocyanic acids as one of the
They are sor
not actually

d-mandelonitrile as the aglycon; *prulaurasin* from cherry laurel leaves racemic mandelonitrile as the aglycon and *sambunigrin* from *Sambucus niger* having l-mandelonitrile as its aglycon.

8. **The Thiocyanate Group.**—The seeds of several cruciferous plants contain glycosides, the aglycon ... When hydrolyzed by the enzyme "myrosin" they ... among these glyco- ... rom white mustard

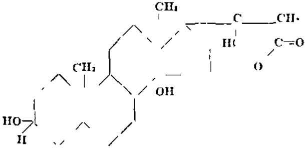
ted in the higher
is in water which
...taining them

blooded animals, many having been used a
yield an aglycon known as a "sapogenin."
lizable compounds upon acetylization by which means they may ... "sapotoxins," and studied The more poisonous saponins are often called "sapotoxins." Quillaja, Senega and Sarsaparilla are among the more important drugs containing saponins and plants such as may be represented by the California soap plant (*Chlorogalum pomeridianum*) which yields amolonin, are sources of saponins used extensively for industrial purposes.

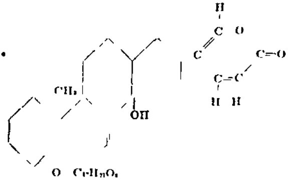


Sarsapogenin

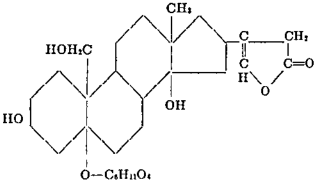
10. The Cardiac Glycosides.—The members of this group are characterized by their highly specific action on cardiac and arterial muscle, increasing tone, excitability and contractility. The group includes *digitoxin* and *digitalin* from Digitalis, the *lanatosides* from *Digitalis lanata*, *strophanthin* and *ouabain* from *Strophanthus* species, the *scillarens* from Squill, *cymarin* from Apocynum, *convallotoxin* from Convallaria and glycosides from Adonis. The aglycons of ... "genins." During the past few ... siderable study and much has ... Stereochemical configuration ... hese compounds



Digitoxigenin



Scillaren A



Ouabain

The ten groups of glycosides discussed above illustrate the wide distribution of this class of compounds in plants. The classification is, however, by no means complete since it is quite possible to find compounds belonging to all classes of organic compounds, combined with glucose or other sugars, in the plant kingdom.

Some glycosides contain more than one saccharide group, possibly as di- or trisaccharides. Upon proper conditions of hydrolysis, one or more of the saccharide groups can be removed from such compounds, resulting in glycosides of simpler structure (see amygdalin below). The most common sugar present is d-glucose although the presence of other sugars such as rhamnose is quite possible. Occasionally rare sugars are found as components of glycosides, such as digitoxose, digitalose and cymarose.

All natural glycosides are hydrolyzed into a sugar and another organic compound by boiling with mineral acids, although they vary widely in the ease with which this hydrolysis is brought about. In most cases, the glycoside is easily hydrolyzed by an enzyme which occurs in the same plant tissue, but in different cells than those which contain the glycoside. Injury to the tissues, the germination process, and perhaps other physiological activities of the cells, result in bringing the enz ... of the latter takes place. ... found in plants, many of ... enzymes, namely **emulsi**... seeds, each hydrolyze a considerable number of glycosides. Glycosides ... are derivatives of rhamnose require a special enzyme, known as rhamnase for their hydrolysis.

Drugs containing glycosides which liberate the physiologically active constituent only upon hydrolysis, and do not contain it in the free state are sometimes known as "Reactionary Drugs."

ROSACEÆ, OR ROSE FAMILY

This is ... of form. ... logical characteristics. The flowers are regular and with ... stamens. In the woody species the pericycle is composed of either isolated groups of bast fibers, or of a complete and continuous sclerenchymatous ring.

Calcium oxalate occurs in the form of solitary crystals or rosette aggregates, and, with the exception of *Quillaja*, styloids are not present. The secretion cells contain either tannin or mucilage. Lysigenous mucilage canals have been found only in *Neurada*. Gummosis of the parenchyma cells of the cortex and wood is characteristic of many of the

species of *Prunus.* The gum exudes spontaneously through rifts or channels in the bark as the result of the pressure of the gum, and collects upon the outer surface in the form of irregular tears. Both glandular and non-glandular hairs are very common to the epidermal tissues of the plants of this family.

The occurrence of cyanophore glucosides in this family is noteworthy.

The Cyanophore Glucosides

Several glucosides which yield hydrocyanic acid as one of the products of their hydrolysis are found to occur in plants Perhaps the most widely distributed of these is **amygdalin.** (It will also be noted that another of the products of the hydrolysis is benzaldehyde, and amygdalin may also be classified in the group of aldehyde glucosides.) Amygdalin is found in large quantities in bitter almonds and in the kernels of apricots, cherries, peaches and plums, in the seeds of apples, and practically all seeds of the *Rosaceæ*

Amygdalin contains two monosaccharide sugar groups, that is, for each molecule of amygdalin, 2 molecules of glucose are formed in the hydrolysis. While these are usually written as linked in ...

particular

charide su

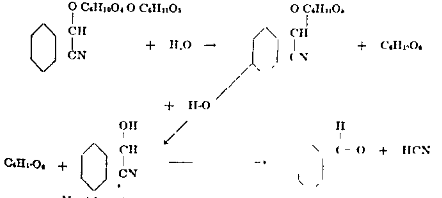
is therefo

dalin tak

1. Most hydrolyzing agents break the molecule first so as to liberate one molecule of glucose and one of mandelonitrile glucoside.

2 In the next step the second molecule of glucose is liberated with the formation of benzaldehyde-cyanhydrin known as **mandelonitrile.**

3. The mandelonitrile then breaks down with the formation of benzaldehyde and hydrocyanic acid



The enzyme **emulsin** as obtained from almond kernels consists of a mixture of two enzymes, amygdalase which causes the first step in the hydrolysis and prunase which causes the second step Besides amygdalin, mandelonitrile glucosides are found occurring in Nature Three such have been isolated, *i. e.*, *d*-mandelonitrile glucoside, *l*-mandelonitrile glucoside and the racemic *d-l*-man...

...ophore glucosides by **microchemical reactions** ... their hydrolysis to hydrocyanic acid Three such reactions might be mentioned as follows

1. Place a fairly thick section of the drug in 5 per cent alcoholic potash for about a minute Transfer it to an aqueous solution containing 2.5 per cent ferrous sulfate and 1 per cent ferric chloride and keep at 60° to 70° C. for about

ten minutes. Transfer to 20 per cent hydrochloric acid. The presence of hydro-

3. The reaction with sodium picrate paper (Guignard Reaction) is carried out

trapping it with a cork. Set aside in a warm place. As soon as hydrocyanic acid is liberated the sodium picrate paper will turn from yellow to brick red or maroon due to the formation of sodium isopurpurate.

Cyanophore glucosides may also be detected in drugs as follows: Saturate pieces of filter paper in a freshly made solution of guaiac resin in absolute alcohol and a ... very dilute solution of copper ... the drug. If

ALMOND

Sweet Almond (U. S. P. 1820 to 1926) and **Bitter Almond** (U. S. P. 1820 to 1916) consist of the ripe seed of *Amygdalus communis* Linné. This plant has been recognized in the U. S. Pharmacopœia as *A. communis* Linné, 1820 to 1842 and 1926 to 1947; as *A communis* L. var. *dulcis* DC. and var. *amara* DC., 1842 to 1916; as *Prunus amygdalus dulcis* DC., 1916 to 1926, and as *Prunus amygdalus* Batsch, 1947 to date.

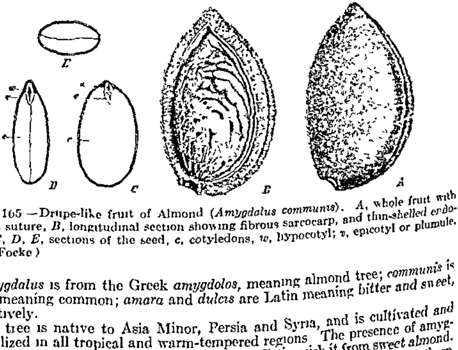


FIG. 165—Drupe-like fruit of Almond (*Amygdalus communis*). *A*, whole fruit with distinct suture, *B*, longitudinal section showing fibrous sarcocarp, and thin-shelled endocarp, *C*, *D*, *E*, sections of the seed, *c*, cotyledons, *w*, hypocotyl; *v*, epicotyl or plumule. (After Focke)

Amygdalus is from the Greek *amygdolos*, meaning almond tree; *communis* is Latin meaning common; *amara* and *dulcis* are Latin meaning bitter and sweet, respectively.

The tree is native to Asia Minor, Persia and Syria, and is cultivated and naturalized in all tropical and warm-tempered regions. The presence of amygdalin in the bitter almond and the bitter taste, distinguish it from sweet almond. Commercial products are obtained mostly from Sicily, southern Italy, southern France, northern Africa and California. In commerce the yellowish, more or ... present (Fig. 165). ... their fixed oil; bitter almond, ... il of importance in medicine.

Sweet almonds are extensively used as a food, but bitter almonds are not suitable for this purpose. The seeds of the bitter almond were known to be poisonous in the days of

forms and in the fourteenth century the almond was an important item of Venetian trade.

DESCRIPTION.—Anatropous, ovate or oblong-lanceolate, flattened, more rounded on one margin, 20 to 30 mm in length, the bitter almond smaller than the

eed coat thin, membranaceous, fracture short, without reserve conical, 2 to 3 mm in length, cotyledons plano-convex, plumule 1 mm. in length, odorless, except on treatment of the bitter almond with water, when odor of hydrocyanic acid is emitted or, if the seeds have been kept for some time, the odor is of benzaldehyde, taste of the bitter almond, bitter; of the sweet almond, bland and sweet

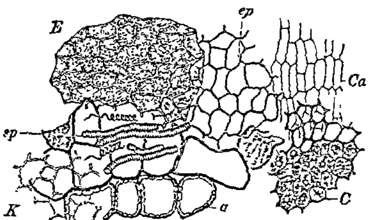


FIG. 166 —Almond Meal *a*, stone cells of the outer epidermis, *K*, brown hypodermal cells, *sp*, spiral tracheæ of the seed coat, *ep*, cells of inner epidermis which contain a brownish content that is not shown here *E*, cells of the endosperm containing numerous small aleurone grains; *Ca*, epidermal cells of cotyledons *C* parenchyma of the cotyledons containing aleurone grains and oil (After Moeller)

STRUCTURE.—In both bitter almond and sweet almond the outer epidermal layer of the seed coat is composed of characteristic, rectangular, somewhat rounded stone cells (see Fig 167) The cells of the embryo contain numerous aleurone grains, from 5 to 15 microns in diameter, and consisting of crystalloids, globoids and calcium oxalate

Almond Meal is prepared by grinding **Almond Cake,** the residue left in the press after removing the fixed oil It is yellowish white in color and contains numerous fragments of parenchyma, containing some oil globules and aleurone grains; also occasional fragments of seed coat Few or no starch grains are present. The almond meal used as a cosmetic is perfumed especially with orris root. A spurious almond meal consists of wheat middlings to which powdered soap and perfume are added

CONSTITUENTS Bitter almond contains fixed oil, 45 per cent proteins, 25 to 30 per cent, a glucoside, amygdalin, 1 to 3 per cent, and a ferment, emulsin, which in the presence of water acts upon amygdalin, decomposing it into a volatile oil (benzaldehyde and hydrocyanic acid) In addition to the protein emulsin, there is another casein-like protein present, amandin. Both of these act as emul

almond contains no amygdalin, hence does not produce the volatile oil. The yield of fixed oil is usually greater than that from bitter almond.

Amygdalin, or a similar principle is found in the young shoots and flower-buds, as well as the seeds of almond, apricot, peach, plum, cherry and cherry laurel. It is separated from bitter almond and occurs commercially as white, slightly bitter crystals, readily soluble in water and in boiling alcohol, insoluble in ether and but slightly soluble in cold alcohol. It has had some use in medicine in place of hydrocyanic acid.

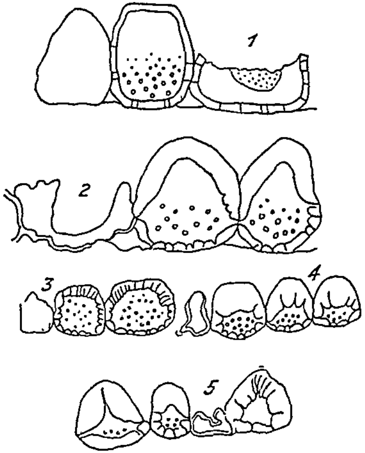


FIG 167 —Epidermal cells of the seed coat of *1*, almond, *2*, peach; *3*, apricot; *4*, plum; *5*, prune. (After Hanning)

USES.—Sweet almond is a nutrient and a demulcent. Bitter almond is used as a sedative; it is also a demulcent. Sweet almonds are used as a food, but bitter almonds are poisonous and are used only for the recovery of the oils. [illegible] of the *Rosaceæ* are sometimes sub- [illegible] bitter and more or less dis- [illegible] [illegible]ot and plum are tangentially elongated, while those of peach are somewhat [illegible] [illegible]wer and more or less conical. For the distinguishing characteristics of these and other seed coats, consult Figure 167.

Expressed Almond Oil or Oil of Sweet Almond (U. S. P. 1820 to date) is the fixed oil obtained from the kernels of varieties of *Prunus Amygdalus* Batsch. [illegible] and subjected to a pressure [illegible] [illegible]

DESCRIPTION, CONSTANTS AND TESTS.—Consult the U S Pharmacopœia. The oil should be free from peach kernel oil, apricot kernel oil, sesame oil, cottonseed oil, olive oil, lard oil, paraffin oil and other fixed oils

USES.—Expressed Oil of Almond is an emollient, a demulcent and a nutrient

Persic Oil, Apricot Kernel Oil, or Peach Kernel Oil (U. S. P. 1938 to date) is the oil expressed from the kernels of varieties of *Prunus Armeniaca* Linné or from the kernels of varieties of *Prunus Persica* Sieb et Zucc.

Persic Oil is prepared in the same manner as expressed almond oil. Its characteristics closely resemble those of expressed almond oil and it is used for the same purposes as this oil

Bitter Almond Oil (U. S. P. 1851 to 1947, N. F. 1947 to date) is the volatile oil obtained from the dried ripe kernels (deprived of fixed oil) of *Amygdalus communis* Linné, or from other kernels containing amygdalin, by maceration with water and subsequent distillation with steam.

DESCRIPTION AND TESTS OF IDENTITY AND PURITY.—See the National Formulary.

STANDARDS.—Oil of Bitter Almond contains not less than 80 per cent of benzaldehyde and not less than 2 per cent and not more than 4 per cent of hydrogen cyanide. Oil in which crystals have formed must not be dispensed. Such crystals consist of benzoic acid and are formed by the oxidation of the

a sedative and is so used in cough remedies.
be used or sold for flavoring foods, because of the presence of hydrocyanic acid. Average dose, 0 03 cc.

Benzaldehyde (U. S. P. 1905 to 1936; N. F. 1936 to date) contains not less than 98 per cent of C_6H_5CHO. It is prepared from bitter almond oil or from chlorinated toluene.

DESCRIPTION, CONSTANTS AND TESTS.—See the National Formulary. Benzaldehyde must be free from hydrocyanic acid, chlorinated compounds and nitrobenzene

USES AND DOSE.—Benzaldehyde is used as an antispasmodic and an anesthetic; commercially, as a flavoring in foods, pharmaceuticals and perfumery. Average dose, 0.03 cc.

Diluted Hydrocyanic Acid or Prussic Acid (U S P 1820 to 1926, N. F. 1926 to 1947) ... solution of HCN.

nond oil It is miscible with
, turning brown, and should
ly poisonous even by inhalation.

Diluted Hydrocyanic Acid is an antispasmodic and sedative, especially in spasmodic cough, also it is used externally in certain skin diseases. Average dose, 0.1 cc.

Mandelic Acid or Racemic Mandelic Acid (U. S. P. 1938 to 1947, N. F. 1947 to date), when dried over sulfuric acid for eighteen hours, contains not less than 99 per cent of $HC_8H_7O_3$.

alcohol.

Mandelic Acid is used as a urinary antiseptic but is not effective unless the urine is at pH 5.5 or less, hence it is usually given as the ammonium, calcium or sodium salt with ammonium chloride. Dose, 4 gm.

CHERRY

Wild Cherry or Wild Black Cherry Bark (U. S. P. 1820 to date) is the stem bark of *Prunus serotina* Ehrhart, collected in autumn and carefully dried. *Prunus* is the classical name of the plum tree; *serotina* means late or backward, referring to the time of flowering and fruiting of the species.

The plant is a tree growing to the height of 100 feet or more in the eastern United States and Canada, the commercial supplies of the drug coming chiefly from Michigan, Indiana, Virginia and North Carolina.

Borke, the sloughing dead tissue which is caused by the formation of adventitious phellogens occurring in the cortex or even in the phloem region, should be removed, a process known as "rossing." There are two commercial grades of bark on the market, a thick and a thin variety, the latter being preferred. The bark is collected in autumn, and should be carefully dried and preserved in air-tight containers.

Wild cherry bark was used by the Indians and no doubt the early settlers learned its use from them. It has long enjoyed popular usage in domestic medicine.

Description, Structure and Powder.—See Figure 168 and the U. S. Pharmacopœia [illegible] glucoside, a com-

Constituents.— [illegible] nd

pound formed by [illegible] of

isomeric with samb[illegible] from the leaves

Sambucus nigra, and prulaurasin (*dl*-mandelonitrile glucoside), from the leaves of *Prunus laurocerasus*.

Wild Cherry also contains a ferment resembling emulsin; *b*-methylæsculetin (methyl ether of dihydroxy-coumarin) which probably occurs in combination as a crystalline glucoside, the solutions giving a blue fluorescence; a phytosterol; *l*-mandelic acid; oleic acid; *p*-coumaric acid; tri-methyl-gallic acid; ipuranol; dextrose, sugar; tannin, starch and calcium oxalate. Total ash, about 4 per cent, acid-insoluble ash, about 0.15 per cent. The yield of hydrocyanic acid varies from 0.23 to 0.32 per cent (inner bark) to 0.03 per cent (trunk bark) and varies even in the bark of the same thickness from the same tree. When the exposure is such that the chloroplastids are abundant in the cells of the bark, the percentage of the *l*-mandelonitrile glucoside is higher, whereas when the exposure is such that the cells do not take an active part in photosynthesis the percentage of the glucoside is lower. In the latter case the bark is yellowish brown. On keeping the bark for a year it deteriorates from 10 to 50 per cent.

Uses and Dose.—Wild Cherry is used as a sedative and pectoral. It is also a tonic and an astringent. Average dose, 2 gm. [illegible] mixed with or

Adul[illegible] atic

substitu[illegible] e sweet,

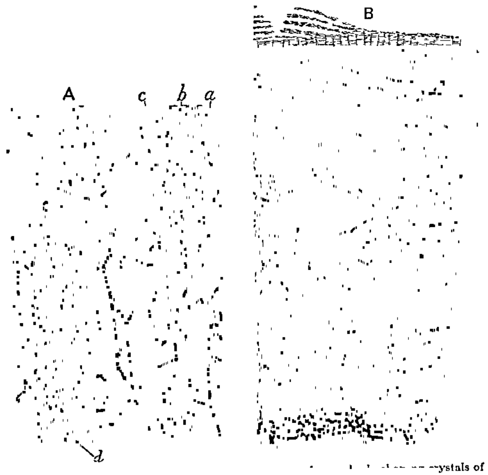
Wild C[illegible] ng **Wild**

slightly [illegible]

Cherry [illegible] ated in

Cherry Laurel, the fresh leaves of *Prunus laurocerasus*, [illegible] water and distilled, forms **Cherry Laurel Water** containing about 0.1 per cent of HCN, and extensively used, especially in Europe, as an anodyne, sedative and antispasmodic, as well as a flavoring agent. Average dose, 1 cc.

... the glycoside laurocerasin, ... n of the glycoside, more ... s much hydrocyanic acid ... cent)



... ystals of ... or sieve ... B, col... companion cells and sieve tubes, K, cambium, L, young xylem (Drawing by ... Gathercoal.)

Cherry or Sour Cherry (N. F. 1936 to 1942) is the fresh, ripe fruit of cultivated varieties of *Prunus Cerasus* Linné. The specific name is from Cerasus in Pontus from which, according to Pliny, Lucullus is said to have introduced *P. cerasus* to grace his triumph over Mithridates. There are many cultivated varieties of this tree, the fruits of which are eaten fresh, canned or used as ingredients in preserves, etc. The trees are cultivated almost universally in the temperate zone. An important commercial source is the fruit belt of Michigan.

The sour cherry fruit is a spherical, depressed, globose or cordate drupe, with a scar at the summit representing the remains of the style, and one at the base representing the point of attachment of the pedicel; up to 20 mm. in

diameter; externally pale red to dark red, glabrous; odor of the crushed fruit characteristically aromatic; taste pleasantly acidulous.

The pulp of the cherry contains up to 2 per cent of malic acid; up to 1 per cent of sucrose; about 9 per cent of invert sugar; 0.2 to 0.4 per cent of pectin; and small amounts of citric and tartaric acids. The kernel contains about 28 per cent of protein; 38 per cent of fixed oil; 0.8 per cent of amygdalin and emulsin. Sour cherries have been used in the preparation of syrup of cherry.

Cherry Juice (N. F. 1942 to date) is the liquid expressed from the fresh, ripe fruit of *Prunus Cerasus* Linné.

The cherries are washed, stemmed, but not pitted, and are coarsely ground to break the pits but not mash the kernels; the mixture is preserved with 0.1 per cent benzoic acid and allowed to stand at room temperature (possibly for several days) until the addition to a small portion of the juice of one-half its volume of alcohol produces a clear solution, which does not become cloudy within thirty minutes. This test indicates that the pectin in the juice has been destroyed by enzymic action and that the juice or the syrup made from the juice can be used in medicinal preparations without causing cloudiness due to the presence of alcohol. The pectin-free juice is pressed out from the mixture and filtered to a clear liquid.

Cherry juice contains not less than 1 per cent of malic acid and not less than 10 per cent of dry solids. It is practically free from arsenic and lead.

Cherry juice is used in the preparation of **Cherry Syrup** (N. F. 1936 to date), which serves as a pleasant disguising agent in pharmaceutical mixtures, especially those of an acidulous nature.

BERRIES

Raspberry or Red Raspberries (U. S. P. 1882 to 1905; N. F. 1916 to 1942) is the fresh ripe fruit of varieties of *Rubus idæus* Linné, or of *Rubus strigosus* Michaux. The generic name ... refers to Mt. Ida, and *strigosus* means lean ... nly culti- vated in temperate portior ... e fruit is collected when ripe in early summer and used while fresh for making the rasp- berry juice, its only pharmaceutical preparation.

Red Raspberry is a red aggregate fruit, hemispherical or somewhat cone-shaped, hollow or with a concave depression at the base where separated from the receptacle, and composed of 20 or more small, rounded-polygonal succulent drupelets; pericarp with numerous, non-glandular hairs up to 640 microns in length; mesocarp fleshy with red juice and occasional rosettes of calcium oxalate, the latter ... tic, endocarp hard an ... fragrant; taste pleasant, sweet, acidulous.

Red raspberry fruit contains about 2 per cent of malic and citric acids, 4 per cent of levulose, 0.5 per cent of sucrose, 0.4 per cent of pectin substances and a small amount of volatile oil to which its distinct flavor is due.

Raspberry Juice or Red Raspberry Juice (N. F. 1942 to date) is the liquid expressed from the fresh ripe fruit of varieties of *Rubus idæus* Linné or of *Rubus strigosus* Michaux.

The f ... 0.1 per cent of ... has been destroyed by enzymic action and then filtered ... juice when mixed with one-half its volume of alcohol produces a clear solution which does not become cloudy within thirty minutes.

Red Raspberry juice contains not less than 1 5 per cent of citric acid and not less than 5 per cent of dry solids. It is practically free from coal tar dyes and from arsenic. The color of the juice fades when exposed to light.

Red Raspberry juice is used in the preparation of **Raspberry Syrup** (U. S. P. 1882 to 1905; N. F. 1916 to date) which serves as a pleasant disguising agent in pharmaceutical mixtures, especially those of an acidulous nature.

Black Raspberries, the fresh, ripe fruit of varieties of *Rubus occidentalis* Linné were permitted, in the N. F. 1916 to 1926, as a substitute, in whole or in part, for Red Raspberries.

Blackberries (N. F. 1916 to 1926), the fresh ripe fruit of varieties of *Rubus nigrobaccus* Bailey or *Rubus villosus* Aiton, were used for the preparation of **Syrup of Blackberry Fruit** (N. F 1916 to 1926), which was used for the same purposes as the Raspberry Syrups.

Blackberries contain, in addition to the acidulous constituents, some tannin, and the **Blackberry Wine** made from this fruit is valued for its astringency.

Strawberries, the fruit of cultivated varieties of *Fragaria chiloensis*, *F. vesca* and *F. virginiana*, contain about the same constituents as red raspberries, and have been used for the preparation of a pleasant acidulous syrup for pharmaceutical use. This syrup is not as acidulous as red raspberry syrup, has never been official, and is used but little.

Rubus or Blackberry Bark (U S P. 1820 to 1916, N F. 1916 to 1936) is the [illegible] face light brown, coarsely longitudinally striate; fracture tough, fibrous, readily splitting, odor slight, taste astringent It contains tannin, 10 to 20 per cent, gallic acid, about 0 4 per cent; a bitter, crystalline glucoside, villosin, somewhat resembling saponin, about 0 8 per cent, starch, calcium oxalate; total ash, about 3 per cent; acid-insoluble ash, about 0 25 per cent Rubus is an astringent and a tonic

Prune (U S. P 1820 to 1916, N F 1916 to 1936) is the fruit of *Prunus domestica*, a small tree indigenous to southern Europe, and largely cultivated in southern France, Germany, Asia Minor and California, but not found growing wild The ripe fruit is partially dried by artificial means or in the sun. The chief source of our supply is California It is a superior drupe, fleshy, ellipsoidal, *more or less compressed, 3 5 to 4 cm in length, externally brownish* black, glabrous, wrinkled The sarcocarp is yellowish brown, fleshy, somewhat stringy, and with a sweet and acidulous taste. The endocarp is ellipsoidal, flattened, about 2 mm in thickness, externally dark brown, reticulate, internally light brown, smooth, 1-locular, 1-seeded, occasionally 2-seeded The seed is about 2 cm in length

Prune contains from 25 to 44 per cent of sugar, organic acids, as malic and tartaric, partly free, about 2 per cent, and about 30 per cent of water It is a laxative and a nutrient, being usually used medicinally in combination with other remedies

Prune Pulp was recognized separately in the U. S P from 1842 to 1862

Fresh Apple Juice (N F 1916 to 1936) is the freshly expressed juice of sound, ripe, sour apples, the fruit of cultivated varieties of *Pyrus malus* Apple juice [illegible] ing amounts of pectin It is a laxative and, [illegible] refrigerant properties

[illegible] P 1851 to 1894) is the ripe seed of *Cydonia vulgaris*, a shrub indigenous to southwestern Asia and extensively cultivated. The generic name refers to Cydonia, an ancient city on the island of Crete

The seed are removed from the ripe fruits, the latter to be used for preserves and dried. The commercial supplies come chiefly from southern Russia and Portugal. T'
being some
2 to 6 mm.
more ... the fracture is short; the inner
surfa ... d
coat, ... us
and ... e-
hyde.

The seed contains mucilage 22 per cent, yielding on hydrolysis, with dilute sulfuric acid, oxalic ac
and the mucilages of ot
creosote water. Upon
thick, transparent jelly should form.

Apple and pear seeds are sometimes substituted. They are readily identified by being ovoid, flattened, acute and pointed at the base, of a uniformly dark brown color and not whitish; and having a smooth, shiny outer surface which is not mucilaginous.

Cydonium is used as a demulcent vehicle for other remedies, especially in skin lotions. It is a frequent constituent of so-called "wave sets."

ROSE

Rose, Red Rose, French Rose, or Rosa Gallica (U. S. P. 1831 to 1936; N. F. 1936 to date) is the dried petals of *Rosa gallica* Linné, collected just before the expansion of the flowers. The generic name *Rosa* is the ancient Latin name for the rose; *gallica* means "of or pertaining to Gaul," now France. The plant is a shrub indigenous to southern Europe and probably western Asia, and extensively cultivated in all parts of the world. The petals are obtained from cultivated plants before the expansion of the flower, the lower clawed portion usually being removed; they are used fresh or are carefully dried and preserved. The chief supply of the drug is obtained from southern France. *Rosa gallica* is said to have been introduced into France in 1241 by the Count of Champagne on his return from the Crusades.

Description —Separate or imbricated, in small cones; petals broadly ovate, the upper part rose-colored and deeply notched the lower part brownish red, more or less rounded, acute or trunca ... , and tudinal veins, texture velvety; odor
slightly bitter

Structure.—See Figure 169.

Constituents.—Volatile oil in small amount, a yellow crystalline rhamnoside, quercitrin which yields on decomposition quercetin and rhamnose; tannin
... d alcohol and gives
... brown with alkalis,
... d a deep blue with
ferrous or ferric salts. Total ash about 4 per cent; acid-insoluble ash about 0.4 per cent
... han 1 per cent of foreign organic
... t of acid-insoluble ash.
... ent and tonic. Average dose, 2 gm.

Rose Oil or Attar of Rose (U. S. P. 1842 to 1916, 1936 to date) is the volatile oil distilled with steam from the fresh flowers of *Rosa gallica*

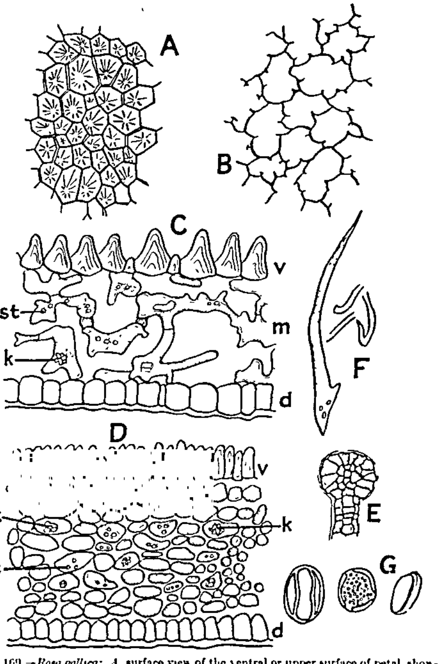


FIG. 169.—*Rosa gallica*: *A*, surface view of the ventral or upper surface of petal, showing polygonal cells, the radiating lines indicating the folds formed by the papillæ. *B*, surface view of cells on the dorsal or lower surface of the petal with inner projections being sometimes of a T-shape. *C*, cross-section from the middle of the petal, showing

Linné, *Rosa damascena* Miller, *Rosa alba* Linné and *Rosa centifolia* Linné, and varieties of these species.

Most of the oil of rose is produced in Bulgaria although a small quantity is distilled in southern France and in Turkey. The flowers are gathered in May and June and subjected to steam distillation in tinned copper stills. The oil which rises to the top of the distillate is pipetted off and the water either marketed as rose water or used to distil a subsequent batch of petals. About 3000 kilos of petals are required to produce 1 kilo of oil. The oil is usually marketed in felt-covered containers.

Description.—A colorless or yellow liquid having the characteristic odor and taste of rose. At 25° C. it is a viscous liquid and upon gradually cooling changes to a translucent crystalline mass, which may be easily liquefied by warming. It has a specific gravity from 0.848 to 0.863 at 30° C.; its optical rotation is −1 to −4 degrees in a 100 mm. tube at 25° C.; refractive index, 1.457 to 1.463 at 30° C.

Constituents.—A colorless stearoptene, 15 to 20 per cent, which is solid at ordinary temperatures; the sesquiterpene alcohols geraniol and citronellol, with smaller quantities of esters of these, and other odorous principles.

Uses.—Oil of Rose is a flavoring agent in pharmaceuticals. It is of great importance in the perfume industry.

Stronger Rose Water (**Rose Water,** U. S. P. 1820 to 1894) (U. S. P. 1820 to date) is a saturated solution of the odoriferous principles of the flowers of *Rosa centifolia* Linné, prepared by distilling the fresh flowers with water and separating the excess volatile oil from the clear, aqueous portion of the distillate. Its odor is best preserved by allowing a limited access of fresh air to the container. The Water is obtained as a by-product, the rose oil being the principal product.

Rosa Centifolia, Pale Rose or Hundred-leaved Rose (Rosa U. S. P. 1820 to 1831) (U. S. P. 1820 to 1905) consists of the petals of *Rosa centifolia* Linné collected after the expansion of the flowers and carefully dried.

Rosæ Caninæ Fructus or Rose Hips are the fresh fruits of *Rosa canina*, a shrub common throughout Europe and the British Isles. The specific name *canina* refers to the fancied shape of the fruit of this species, meaning, "like a dog." It is sometimes called the "dog hip." They are ovoid, from 15 to 20 mm in length; externally of a red or scarlet color, smooth and shiny, and having at the summit the 5 calyx-teeth, beyond which project the hairy appendages of the achenes; the pericarp is of a fleshy texture, becoming on maturity, especially after frost, soft and pulpy, the pulp of the sarcocarp being of an orange color and an agreeable, acidulous taste; the hollow receptacle bears on its inner surface numerous, small, hard achenes, which, as well as the walls of the former, are covered with unicellular, thick-walled hairs. Rose hips contain citric acid, 3 per cent; malic acid, 8 per cent; mucilage, 25 per cent; an uncrystallizable sugar, 30 per cent; also citrates, malates and mineral salts. They are mildly astringent, refrigerant and diuretic.

QUILLAJA

Quillaja, Soap Tree Bark or Soap Bark (U. S. P. 1882 to 1916; N. F. 1916 to date) is the dried inner bark of *Quillaja Saponaria* Molina. The name *Quillaja* is derived from the Chilean vernacular, *quillai*, meaning "soap," because the bark of the plant forms a lather with

water; *saponaria* refers to the same character. The plant is a large tree indigenous to Chile and Peru.

Description, Structure and Powder.—See Figure 170 and the National Formulary.

Constituents.—The drug contains two amorphous glucosides amounting to about 9 per cent, which are closely related to saponin—one soluble in alcohol and known as quillajic acid, and the other nearly insoluble in alcohol and known as quillajasapotoxin; both yield the corresponding sapogenins upon hydrolysis. Total ash from 5 to 10 per cent, nearly all of which is soluble in diluted hydrochloric acid

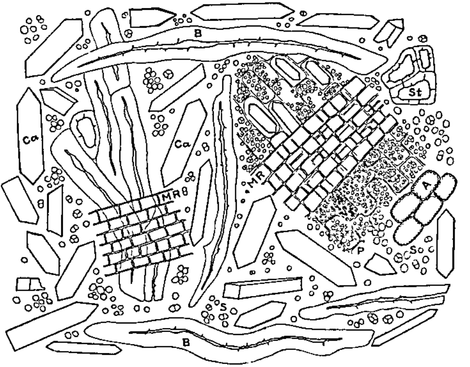


Fig 170 Powdered Quillaja pinkish white, very sternutatory, calcium oxalate in prisms (*ca*) from 35 to 200 microns in length, bast fibers (*B*) numerous, thick-walled, strongly lignified, occasionally with branching ends, crystal fibers containing elongated prisms of calcium oxalate, stone cells (*St*) more or less thick-walled and with simple, oblique pores, starch grains (*S*) nearly spheroidal from 3 to 10 microns in diameter, parenchyma (*P*) containing starch and calcium oxalate, medullary rays (*MR*) and parenchyma (*A*) with cell walls bearing simple pores

Standards. Soap bark contains not more than 5 per cent of adhering outer bark and not more than 1 per cent of foreign organic matter, and yields not more than 2 per cent of acid-insoluble ash.

Uses —Quillaja is used as an emulsifying agent, particularly for tars It is irritant and expectorant but because of its depressant action on the heart and respiration should not be employed internally.

Brayera, Cusso or Kousso (U. S. P. 1863 to 1916, N F. 1916 to 1936) is the pistillate flowers of *Hagenia abyssinica*, a tree indigenous to northeastern Africa and cultivated in Abyssinia The entire panicles are collected soon after pollination and dried in the sun, the flowers are sometimes stripped from the panicles, or the panicles are made into rolls.

The flowers are shown in Figure 171.

The activ...
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... compounds which are inactive.

Cusso is used as an anthelmintic and as a tænifuge.

Tormentilla (*U .S. P. 1820 to 1882*) is the *rhizome* of *Potentilla tormentilla*, indigenous to central and northern Europe and northern Asia. *It contains* tannic acid from 18 to 30 per cent; tormentilla red, a product of decomposition of the tannin; ellagic acid; a trace of volatile oil and a resin. Tormentilla is used as an astringent and as a tonic.

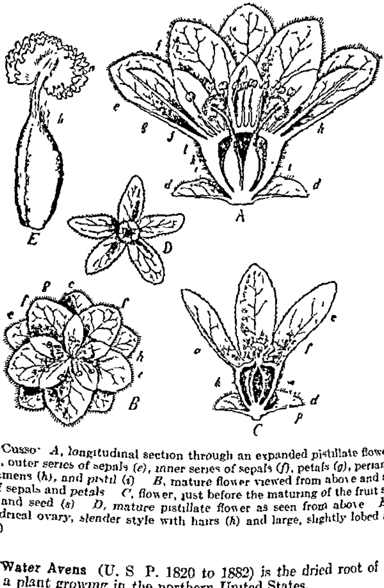


FIG 171 —Cusso· *A*, longitudinal section through an expanded pistillate flower showing bracts (*d*), outer series of sepals (*e*), inner series of sepals (*f*), petals (*g*), perianth tube (*k*), sterile stamens (*h*), and pistil (*i*) *B*, mature flower viewed from above and showing the relation of sepals and petals *C*, flower, just before the maturing of the fruit showing pericarp (p), and seed (*s*) *D*, mature pistillate flower as seen from above *E*, pistil showing cylindrical ovary, slender style with hairs (*h*) and large, slightly lobed stigma. (After Meyer.)

Geum or Water Avens (U. S P. 1820 to 1882) is the dried root of *Geum rivale* Linné, a plant growing in the northern United States.

The perennial root is horizontal, jointed and scaly, about 15 cm. long, with numerous, descending, yellow rootlets It is reddish brown externally and white internally. It is hard and brittle; inodorous; bitter and astringent. It has been used as an astringent. Dose, 1 to 4 gm.

Spirea or Hardhack (U. S. P 1820 to 1882) is the root of *Spirea tomentosa* Linné. The plant is a shrub indigenous to eastern United States and Canada and westward to Minnesota and Kansas The roots are woody, with brown bark and an astringent taste. It has been used as an astringent in doses of 0.5 to 1.5 gm.

LEGUMINOSÆ, OR PULSE FAMILY

This is the second largest family of flowering plants and comprises over 500 genera and about 12,000 species. These are widely distributed, being most numerous in the tropical and subtropical regions. They exhibit a great range of habit, from creeping annual herbs to climbing shrubs, and vary from delicate herbs to very tall trees. The plants are characterized by alternate, stipulate, usually compound leaves; papilionaceous or sometimes regular flowers, having monadelphous or diadelphous stamens and a single free pistil. The fruit is a legume from which the family receives its name

It is divided into subfamilies as follows:

1. *Papilionaceæ*, with irregular, papilionaceous flowers, and calcium oxalate in the form of styloides or small rod-like crystals, these being not infrequently inserted in the thickened cell walls. Tannin sacs, resin canals, lysigenous gum canals and other secretory cavities occur in the species of this group. About two-thirds of the *Leguminosæ* belong to this subfamily, which yields important drugs and economic products

2. *Cæsalpinaceæ*, in which the corollas are imperfectly or not at all papilionaceous. These plants usually contain, in addition to solitary crystals, rosette aggregates of calcium oxalate.

3. *Mimosaceæ*, in which the flowers are small and regular; calcium oxalate may occur in the form of rhombohedral crystals or styloides, occasionally being imbedded in the thickened cell wall. Secretion sacs in the phloem strands are common. In some species the walls of the cells of the pericycle, the phloem and wood undergo a metamorphosis into mucilage, which then exudes and collects in the form of tears upon the outside of the bark of the branches. With acacia gum it appears that the cell contents of the pith and medullary ray cells is converted into the mucilage. **Cassie Oil**, used in perfumery, is from this subfamily.

GLYCYRRHIZA

Glycyrrhiza or Licorice Root (U. S. P. 1820 to date) is the dried rhizome and roots of *Glycyrrhiza glabra* Linné var. *typica* Regel et Herder, known in commerce as Spanish Licorice, or of *Glycyrrhiza glabra* Linné var. *glandulifera* Waldstein et Kitaibel, known in commerce as Russian Licorice (U. S. P. 1890 to date), or of other varieties of *Glycyrrhiza glabra* Linné yielding a yellow and sweet wood. *Glycyrrhiza* is of Greek origin and means sweet root; *glabra* means smooth, and refers to the fruit of this species which is a smooth pod In the species *glandulifera* the fruit has gland-like swellings.

The plant is a perennial herb attaining a height of 1 to 1.7 meters The underground portion of the variety *typica* (Spanish licorice) consists of several horizontal, spreading rhizomes bearing buds and of branching roots which penetrate the soil to a depth of several feet. In the variety *glandulifera* (Russian licorice) the underground portion consists of a large rhizome which gives off long, thick, fusiform roots.

Until 1870 Spain produced practically the entire world's supply of licorice root. Now most of the countries bordering the north side of the Mediterranean Sea, along with Arabia, Syria and Iran, cultivate the variety *typica;* wild plants of the variety *glandulifera* found on the borders of the Black and Caspian Seas furnish most of the Russian licorice. Experimental lots of licorice root have been produced by cultivation in California and Oregon, where there are great areas well adapted to it, yet until mechanical means reduces the high labor cost the United States will not become a competitor in the production of licorice. Over 75,000,000 pounds of the drug are imported annually, besides 1,500,000 pounds of the licorice extract.

Fig. 172.—A bundle of Spanish Licorice root from the Pharmacognosy Museum of the University of Illinois. (Photo by R. S. Adamson.)

Propagation of the variety *typica* is generally by cuttings of the rhizome which are planted in rows about 4 feet apart. At the end of the third or fourth year the rhizome and roots are dug, preferably in the autumn and from plants which have not borne fruit, so as to insure maximum sweetness of the sap. The washed material is air-dried (four to six months), packed into bales or cut and tied into short cylindrical bundles (see Fig. 172). The large thick roots of Russian licorice are peeled before drying. In southern Italy a considerable amount of the crop is extracted with water, the liquid being clarified and evaporated, and the resulting extract molded into sticks, etc.

Description, Histology and Powder.—See Figures 172, 173, 174 and the U. S. Pharmacopœia.

Constituents.—From 3 to 12 per cent of glycyrrhizin; glucose, about 3 per cent; sucrose, about 5 per cent, asparagin, about 3 per cent; mannite and a

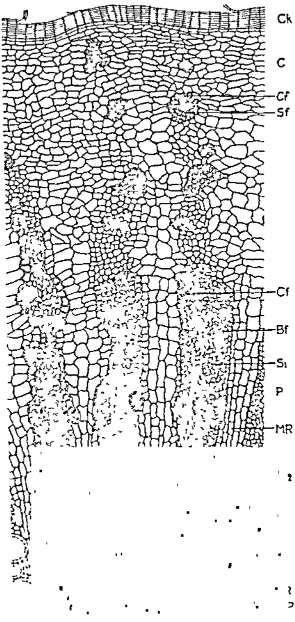


Fig. 173.—Spanish Licorice in transverse section. *Ck*, cork of numerous layers of yellowish brown cells, *C*, cortex, with outer rows collenchymatous and inner portion parenchymatous, with groups of fibers (*Sf*), more or less surrounded by crystal fibers (*Cf*). *P*, phloem with alternating strands of bast (*Bf*) and sieve (*Si*), the cells of the latter with thickened highly refractile walls. *MR*, medullary rays from 1 to 8 cells wide and definitely radiate, alternating with the phloem. *Ca*, cambium, narrow and inconspicuous. *X*, xylem region with broad wood wedges containing bundles of wood fibers (*Wf*) associated with crystal fibers (*Cf*), large tracheæ (*Tr*) and thin-walled, non-lignified wood parenchyma (*WP*). the parenchyma cells of the bark, medullary rays and wood bear an abundance of starch. (Drawing by Harry Flower.)

bitter principle known as glycyramarin, which occurs principally in the bark and hence is less abundant in the Russian licorice.

STANDARDS.—Glycyrrhiza yields not more than 2.5 per cent of acid-insoluble ash.

USES AND DOSE.—*Glycyrrhiza* is a demulcent, an expectorant and a mild laxative. It is considerably used as a flavoring agent and is frequently used to mask the taste of such drugs as aloe, ammonium chloride, quinine, etc.

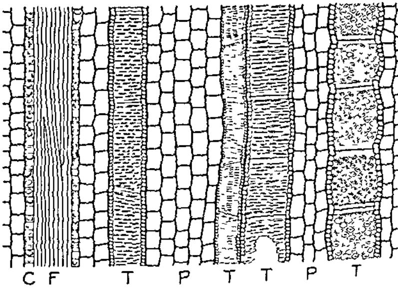


FIG 174.—Spanish Licorice in longitudinal section through the xylem region: *C*, crystal fibers, *F*, wood fibers, *T*, reticulate and dotted tracheæ, *P*, starch-bearing parenchyma. (Drawing by Harry Flower.)

Glycyrrhiza Extract, Extract of Licorice, or Licorice (U. S. P. 1820 to date) is a commercial extract prepared by extracting coarsely ground licorice root, usually the inferior grades, with warm water, clarifying the extract and evaporating it almost or quite to dryness. Spanish licorice is used almost exclusively for preparing this extract.

Glycyrrhiza extract occurs as a brown powder or in flattened, cylindrical rolls or in masses. The rolls and masses have a glossy black color externally and a brittle, smooth, conchoidal fracture, the taste is sweet and characteristic Not less than 75 per cent of the extract is soluble in cold water. It contains no foreign starch and yields not more than 5 per cent of ash. ...facture of pills and ...ra- ...ing

tobacco.

Ammoniated Glycyrrhizin (U S. P. 1882 to 1926) is glycyrrhizin combined with ammonia, and occurs as dark brown or brownish red scales, without odor, but having a very sweet taste. It is freely soluble in water and in alcohol An aqueous solution supersaturated with an acid precipitates glycyrrhizic acid ($C_{44}H_{64}O_{19}$) In the plant this acid is combined with calcium or potassium to form glycyrrhizin. Glycyrrhizic acid occurs as an amorphous, yellow powder, having a strong bitter-sweet taste and an aci... ...solution in hot water forms a jell on cooling. Boiled ... glycyrrhetic acid and glycuronic acid, but no sugar... side. However, glycuronic acid is an oxidation product of glucose.

Wild or American Licorice is the root of *Glycyrrhiza lepidota*, a perennial

the root of *Ononis spinosa*, a perennial herb of Europe, and other species of *Ononis* as well; the locust (*Robinia pseudacacia*) of the United States and Canada (see page 360); *Caragana pygmæa* of Siberia and northern China, *Hedysarum americanum* of the northern United States and Canada; *Periandra mediterranea*, and *P. dulcis* of Brazil and Paraguay; and Wild Licorice, *Galium circæzans*, also the root of the English walnut, *Juglans regia* (Fam *Juglandaceæ*); and the rhizome of *Polypodium vulgare* (Filices).

Gums and Mucilages

A short discussion of gums and mucilages is introduced at this point because the two principal items in this class of drug products are Tragacanth and Acacia which come from this family.

Gums are translucent, amorphous substances usually produced by plants as a protective after injury. They, together with the mucilages, pectins and celluloses belong to a class of substances which are condensation products of the pentoses They may be pentosans, having the formula $(C_5H_8O_4)_n$ or hexosans, having the formula $(C_6H_{10}O_5)_n$, or combined pentosan-hexosans. The gums, when hydrolyzed, yield large proportions of sugars and also contain a complex organic acid nucleus, by means of which they form salts with calcium, magnesium, etc. Gums are precipitated from solution by alcohol and lead subacetate solution

An effort has been made to distinguish between mucilages and gums on the basis that gums readily dissolve in water and mucilages do not dissolve, but form slimy masses Others have tried to distinguish between them on the basis that gums are physiological products and mucilages are pathological products, but this classification has not been very successful. It is interesting to note that pectins, which are closely related to gums and mucilages, form aqueous colloidal solutions which are easily converted into "jellies;" cellulose is unaltered in water.

Mucilages are generally sulfuric acid esters where the ester group is a complex polysaccharide. Both gums and mucilages are generally considered as decomposition products of cellulose.

Gums and mucilages are closely related to the hemicelluloses in composition and function except that where the principal sugars produced by hemicelluloses are glucose, mannose and xylose, those produced by gums and mucilages are galactose and arabinose. Gums and mucilages also contain various uronic acids. Acacia and damson gum contain glucuronic acid units and the mucilages from elm bark and linseed contain galacturonic acid. Pectins are also composed of polygalacturonic acid units and sugars. The mucilages found in seaweeds (agar, chondrus) consist of salts of alginic acid, the latter containing *d*-mannuronic acid residues.

Gums and mucilages are produced in various ways by the plant which may be noted as follows:

1. Formed from the middle lamella as in the algæ:
   Agar, 65 per cent gelose.
   Chondrus, 55 to 80 per cent carrageenin.
   Fucus, 22 to 65 per cent mucilage.
   Laminaria, about 50 per cent mucilage.
2. Formed from the cell wall:
   (*a*) Of the seed epidermis:
      Linseed mucilage.
      Quince seed mucilage.
      Psyllium seed mucilage.
   (*b*) Of the seed endodermis:
      Fenugreek.
   (*c*) Of cells in the bark:

3.
   Squill.
4. Formed in schizogenous sacs:
   Young stems of *Rhamnus purshiana*.
5. Formed by lysigenous metamorphosis of the cell walls:
   Tragacanth.
   Acacia.
   Sterculia gum.
   Ghatti gum.
   Cherry gum.
   Mesquite gum.

TRAGACANTH

Tragacanth or Gum Tragacanth (U. S. P. 1820 to date) is the dried gummy exudation from *Astragalus gummifer* Labillardiere, or other Asiatic species of *Astralagus*. The name tragacanth is from the Greek *tragos* (goat) and *akantha* (horn) and probably refers to the curved shape of the drug; *astragalus* means milk-bone and refers to the exuding and subsequent hardening of the drug; *gummifer* is Latin, meaning gum-bearing. The plants are thorny branching shrubs about one meter in height, and are abundant in the highlands of Asia Minor, Iran, Kurdistan, Syria, Armenia and Greece. When the plant is injured the cell walls of the pith and then of the medullary rays are gradually transformed into gum. This absorbs water and creates internal pressure within the stem, thus forcing the gum to the surface through the incision causing the injury. When the gum strikes the air it gradually hardens due to the evaporation of the water. The nature of the incision governs the shape of the final product. That exuding from natural injuries is more or less worm-like and twisted into coils (**vermiform tragacanth**) or in irregularly shaped tears (**tragacanth sorts**) of a yellowish or brownish color. The better grade is from transverse incisions in the main stem and older branches made with a knife. The gum from such incisions is ribbon-like, showing longitudinal striations caused by small irregularities in the incision. The metamorphosis takes place only at night and the tragacanth ribbons exhibit transverse striations showing the amount that exudes each night. The shorter the time of drying the whiter and

more translucent the ribbons will be. This ribbon form of tragacanth is graded commercially by numbers, No. 1 being almost colorless (white) and nearly translucent, No. 2 and No. 3 have more color and opaqueness. Tragacanth was known to Theophrastus (300 B.C.) and Dioscorides and seems to have been used during the Middle Ages. It was not until very recent times, however, that the natives learned to clean the bases of the bushes and incise the bark with a knife, thus producing the clean, white, semi-transparent product of present day commerce. The principal points of export are Smyrna and various ports along the Persian Gulf. That obtained from the latter is known as **Persian or Syrian Tragacanth** and is preferred.

mm.
in rless
to rac-
tu ° C.
Pieces of the gum softened in water and mounted in glycerin show numerous lamellæ and a few starch grains

POWDER.—White to yellowish white, inodorous; taste insipid and mucilag-
4-c
in

no. dissolve and which g
to distinguish it from ac
soluble compound of arabic and ironic acids, about 30 per cent, total ash, 1 5 to 3 per cent, mostly soluble in diluted hydrochloric acid.

STANDARDS AND TESTS —
and forms a smooth, nearly
fragments (2) Powdered
vegetable tissue (3) Boil 1 gm of tragacanth with 20 cc of distilled water until a mucilage is formed, then add 5 cc of hydrochloric acid and again boil the mixture for five minutes, it develops no pink or red color These tests all serve to detect sterculia (karaya) gum which contains lignified vegetable tissue, gives a more or less stringy mucilage and reacts pink with hydrochloric acid Powdered tragacanth has been adulterated with cereal starches.

USES.—Tragacanth is a demulcent It is employed pharmaceutically as a suspending agent for insoluble powders in mixtures, as an emulsifying agent for oils and resins; and as an adhesive in pill and troche masses It is also employed in cosmetics (hand lotions), as an emollient, and in calico printing, confectionery, etc

Sarcocolla is a gummy exudation of *Astragalus sarcocolla* and *A. mucronata*, small shrubs indigenous to southern and central Africa The gum occurs in small, globular, yellowish red or brownish red friable grains, which are often agglutinated into masses and admixed with a few hairs Sarcocolla has a licorice-like taste It is soluble in water and alcohol, and contains an uncrystallizable principle, sarcocollin, having a taste of glycyrrhizin, a resin and a gum

KINO

Kino (U. S. P 1820 to 1912; N. F. 1912 to date) is the dried juice obtained from the trunk of *Pterocarpus Marsupium* Roxburgh The name *Pterocarpus* is Greek and signifies a winged carpel or fruit, *Marsupium* is Latin, meaning a bag or pouch and refers to the shape of the

cause the bark to separate from the trunk, four intermediate strips being left uninjured so as not to kill the tree; within a week the bark drops from the trunk and the balsam begins to exude freely from the exposed wood. The areas are then wrapped with rags which are removed from time to time when they become saturated with balsam; then they are boiled with water and as the water cools, the balsam settles out, is recovered, strained and packed, usually in tin cans. Most of the commercial supply comes from Salvador, although some is produced in Honduras.

DESCRIPTION.—A dark brown, viscid liquid, reddish brown and transparent in [illegible] -matic, var[illegible] ol, in chl[illegible] leum benzin. *Specific gravity 1.15 to 1.17 at 25° C.*

CONSTITUENTS.—Cinnamein, about 60 per cent, which is a volatile oil consisting chiefly of benzyl cinnamate, and lesser amounts of benzyl benzoate and cinnamyl cinnamate; resin esters 30 to 38 per cent, mostly peru-resinotannol cinnamate with a small quantity of the benzoate; vanillin, free cinnamic acid, peruviol, etc, in small amounts.

STANDARDS AND TESTS.—Peruvian balsam yields not less than 50 nor more than 60 per cent of cinnamein, of which the saponification value is between 230 and 240 The acid value of Peruvian balsam lies between 56 and 84 It should be free from oil of turpentine, rosin and fixed oils.

USES.—Peru balsam is an anti-parasiticide in certain skin diseases. It is an antiseptic and vulnerary and is applied externally, either alone or in alcoholic solution, also in the form of an ointment. *Internally it is a stimulating expectorant.* Its internal use is rather rare.

TOLU BALSAM

Tolu Balsam, Tolu, or Balsam of Tolu (U. S. P. 1820 to date) is obtained from *Myroxylon Balsamum* (Linné) Harms.

The balsam trees grow abundantly along the lower Magdalena River, Colombia. According to Tschirch, the plants yielding Tolu and Peru balsams are physiological varieties of the same species. Tolu is a district near Cartagena, where the balsam was once extensively produced.

Balsam of Tolu is usually considered to be a pathological product similar to balsam of Peru or coniferous oleoresins. V-shaped incisions are made through the bark and sap wood and calabash cups are placed to receive the flow of balsam. Similar cuts are made higher up on the trees, sometimes as many as twenty incisions being made on one tree. The balsam is collected from the cups and transferred to tin containers in which it is shipped.

Some balsam of Tolu is also produced in Venezuela and New Granada and the trees are now being cultivated in the West Indies Tolu balsam was found in use by the natives upon the discovery of what is now Colombia and Venezuela by the Spanish. *Monardes* (1574) describes its collection, stating that the drug was much esteemed by the Indians and later by the Spanish, who introduced it into Europe.

DESCRIPTION.—A plastic solid, which gradually hardens, becoming yellowish or reddish brown; transparent in thin layers; pulverizable when old, dried or

namic acid; odor agreenatic, slightly pungent. potassium hydrate

CONSTITUENTS.—Resin esters, 75 to 80 per cent, chiefly tolu-resinotannol cinnamate with a small quantity of the benzoate, volatile oil, 7 to 8 per cent, chiefly benzyl benzoate; free cinnamic acid, 12 to 15 per cent, free benzoic acid, 2 to 8 per cent; vanillin, and other constituents in small quantities

STANDARDS.—Tolu balsam has an acid value of not less than 112 and not more than 168, and a saponification value of not less than 154 and not more than 220. It should be free from rosin, rosin oil or copaiba

USES —Tolu is an expectorant, it is extensively used as a pleasant flavoring in medicinal syrups, confectionery, chewing gum and perfumery.

CHRYSAROBIN

Chrysarobin (U. S. P. 1882 to date) is a mixture of neutral principles obtained from Goa powder, a substance deposited in the wood of *Andira Araroba* Aguiar. *Andria* is of Portuguese origin, *Araroba* is the Latinized East Indian name of the bark, *aroba; Chrysarobin* is from the Greek *Khrysos*, meaning gold, and from *aroba* Goa is the Portuguese colony on the Malabar Coast to which the plant was imported in 1852. This is a large tree found in the provinces of Bahia and Sergipe in Brazil.

Goa Powder arises in the living cells of the wood of the stems. The cell walls become metamorphosed and finally disintegrated, forming large lacunæ, in which are deposited the altered products in the form of a yellowish brown powder, which is more or less admixed with the tissues of the bark and wood. The trees are hewn and cut into convenient pieces, the Goa powder being scraped out The crude article is purified by sifting it free from fragments of wood, drying and powdering

Goa powder is of a light yellow color when fresh, but on exposure to air becomes dark brown or brownish purple It is composed of small, wine-colored, somewhat translucent, irregular, angular fragments, with a few fragments of tracheæ and libriform cells having bordered pores It is nearly insoluble in water, but soluble in alcohol, chloroform and solutions of the alkalis, the latter being colored deep red and showing a green fluorescence It contains from 50 to 75 per cent of a neutral principle, chrysarobin, about 2 per cent of resin, 7 per cent of bitter extractive, a small amount of chrysophanic acid, and yields about 3 per cent of ash Under the microscope the powder sometimes shows colorless prismatic crystals

Chrysarobin is prepared by extracting Goa powder with hot benzene, evaporating the solution to dryness and powdering It is a brownish to orange-yellow microcrystalline powder, odorless and tasteless but irritating to the mucous membrane

CONSTITUENTS Chrysaphanolanthrone or chrysaphanol anthranol, 30 to 40 per cent, emodinanthrone-monomethyl ether, about 20 per cent and dehydro-emodinanthrone-monomethyl ether, about 30 per cent, these compounds are related to the anthraquinones, and chrysarobin has a laxative action although it is not suitable for internal use

STANDARDS AND TESTS Chrysarobin dissolves in solutions of the alkali hydroxides and in sulfuric acid producing deep red solutions Place about 2 mg of chrysarobin on a tile and add 2 drops of fuming nitric acid the mixture is reddish brown, now add a few drops of ammonia T.S and an intense violet color is produced. This test serves to differentiate chrysarobin (or Goa powder)

from chrysophanic acid and other anthraquinone compounds or anthraquinone drugs.

Uses.—Chrysarobin is an irritant and an antiparasiticide. It is used externally. Since it stains badly it should not be used on the face.

PHYSOSTIGMA

Physostigma, Calabar Bean, or Ordeal Bean (U. S. P. 1873 to 1926) is the dried ripe seed … ling not less than 0 15 per cent of the al…

The name … n inflated or bladder-like stigma (see F … meaning full of poison

The plant is … the banks of streams in Western Africa, particularly in the vicinity of the Gulf of Guinea. In 1846 Daniell described the use of the seed, known as *esere* by the natives of old Calabar, to prove the innocence or guilt of persons accused of crime. The plant was not classified until 1860.

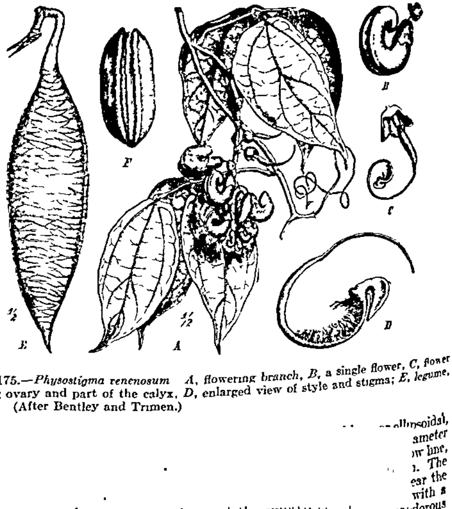


Fig. 175.—*Physostigma venenosum* *A*, flowering branch, *B*, a single flower, *C*, flower showing ovary and part of the calyx, *D*, enlarged view of style and stigma; *E*, legume, *F*, seed. (After Bentley and Trimen.)

… ellipsoidal, … ameter … ow line, … The … ear the … with a groove. Reserve layers are wanting and the embryo … short hypocotyl and two concavo-convex cotyledons. The drug is inodorous and the taste starchy.

The embryo contains numerous starch grains, from 10 to 100 microns in diameter, ellipsoidal or somewhat reniform, and usually with a distinct cleft and frequently with radiating or irregular fissures.

Calabar bean contains starch; proteins; a small amount of fixed oil; several alkaloids, of ... mportant, several phytosterol glucosides; a ... resinous material Total ash about 3 5 per ... per cent

Physostigmine Salicylate or Eserine Salicylate (U. S. P. 1882 to date) occurs in colorless or faintly yellow, shining, odorless crystals. It crystallizes from chloroform in rhombohedra (Fig 176), which are colored red by solutions of the alkalis and yellow by sulfuric or nitric acid. See the U. S. Pharmacopœia for solubilities and tests.

Fig. 176.—Physostigmine salicylate orthorhombic crystals from a solution in chloroform

Uses and Dose —Physostigmine salicylate is a myotic It stimulates peristalsis and glandular secretions Average dose, 2 mg

Physostigmine Sulfate, or Eserine Sulfate (U S P 1894 to 1916) contains about 20 per cent more of the physostigmine than does the salicylate. It is much preferred by veterinarians and is used subcutaneously as a laxative and for gastric and intestinal catarrh.

Allied Plants —The seeds of *P. cylindrospermum* have been substituted for Calabar bean; they are nearly cylindrical and are said also to contain physostigmine.

The lenticular, brown, glossy seeds of *Entada scandens* contain saponin and have been offered as a substitute for physostigma *Canavalia obtusifolia*, of the East Indies, is also said to have been used as an adulterant of physostigma.

SCOPARIUS

Scoparius, or Broom Tops (U S. P. 1831 to 1916; N. F. 1916 to 1936) consists of the dried tops of *Cytisus scoparius* (Linné) Link. The plant is a shrub growing in Europe and western Asia and naturalized in the United States. The tops are gathered before flowering and carefully dried. While some of the

drug is gathered in Oregon, most of the commercial supplies are imported from Britain or southern Europe.

Scoparius branches are alternate, pentangular, 1 to 3 mm. in thickness; externally dark green, with 5 yellowish green wings and numerous reddish brown cork patches, the younger branches somewhat pubescent; they are usually cut into short pieces

The leaves are elliptical, obovate, simple, about 5 to 10 mm. in length, digitately trifoliate below; upper surface dark green, nearly glabrous; under surface slightly pubescent; the petiole is wanting in the simple leaves and is about 5 mm. in length in the compound leaves, and pubescent; the drug has a peculiar odor and bitter taste.

Powdered scoparius is dark green with 1-celled non-glandular hairs up to 700 microns long, and thick-walled tracheæ with slightly lignified spiral or double spiral thickenings; narrow, thi
simple pores; and fragments of leaf and
and epidermis, the latter with broadly
length.

The drug contains the volatile, liquid alkaloid sparteine (0.3 per cent); the yellow crystalline flavone scoparin; and about 3 per cent of ash.

Sparteine Sulfate (U. S. P. 1894 to 1926; N. F. 1926 to date), $C_{15}H_{26}N_2 \cdot H_2SO_4 \cdot 5H_2O$, gives sparteine 55.45 per cent, sulfuric acid 23.22 per cent, and water 21.33 per cent; it occurs in colorless rhombohedral crystals or white crystalline powder, is odorless and somewhat bitter in taste. Consult the National Formulary for constants, standards and tests.

Sparteine sulfate is used, particularly by veterinarians, as a cardiac tonic and diuretic. Average dose for humans, 30 mg.; for horses, 1 to 4 gm.

Allied Plants.—Several plants of the *Leguminosæ* are used like scoparius. Spanish broom is obtained from *Spartium junceum*, a shrub indigenous to the Mediterranean region. *Coronilla scorpioides* yields a yellow glucoside, coronillin.

TONKA

Tonka or Tonquin Beans are the ripe seeds of *Coumarouna odorata* (Dutch Tonka) and *C. oppositifolia* (English Tonka), trees growing in the Amazon region and north to Guiana. The fruits are crushed between stones, the seeds separated and dried in the sun, then steeped in rum or other alcoholic liquors, and by a process of fermentation the fragrant principle, coumarin, is developed, when the seeds are drie[d] ... their surface.

Tonka beans are oblo[ng] ... length and about 1 cm. in width, ... [w]ith crystals of coumarin, the coriaceous testa being deeply wrinkled. ...lly they are yellowish brown, consisting of two plano-convex cotyledons, enclosing a plumule with two pinnately compound leaves and a fleshy radicle which is directed towards the micropyle situated at the rounded end of the seed. The odor of the seed is fragrant and the taste aromatic and somewhat pungent.

... about 25 per cent of fixed ... 4 per cent. ... It is said to be a narcotic stimulant.

Coumarin (N. F. 1916 to date), $C_9H_6O_2$, is the lactone of ortho-hydroxy cinnamic acid. It occurs in colorless, prismatic crystals, with a characteristic fragrant odor and a bitter, aromatic burning taste. It

is soluble in alcohol, ether and chloroform and melts between 67° and 69° C.

Coumarin is obtained from tonka, where it is apparently developed from a mother substance contained in the fixed oil; it is also prepared synthetically from salicyl-aldehyde by boiling it with acetic anhydride and anhydrous sodium acetate.

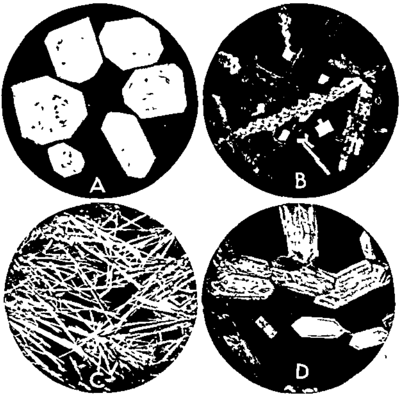


FIG 177 —Coumarin Type *A*, tabular crystals obtained by cooling melted coumarin to 67° to 69° C, type *B*, aggregates of tabular crystals, type *C*, needles, type *D*, short prisms obtained from hot aqueous solutions.

The microchemistry of coumarin has been discussed in connection with vanillin (see pages 189, 190), for which it is occasionally found as a substitute. It may be readily obtained by microsublimation, usually occurring in prisms with oblique edges. With chlor-zinc-iodide, coumarin yields long, delicate, more or less bent, crystalline threads, brownish violet in color and tending toward clumping.

STANDARDS AND TESTS.—Coumarin should be free from vanillin and acetanilid (see National Formulary for tests).

Coumarin is rather widely distributed in Nature. Of the plants in which it

sweet vernal
'eer's tongue
lotus, as well
im triflorum),
Vitis sessili-
of Europe.

Melilotus, Yellow Melilotus, or Yellow Sweet Clover (U S P. 1916 to 1926) is the dried leaves and flowering tops of *Melilotus officinalis* (Linné) Lamarck.

The plant is a biennial herb indigenous to Europe, but naturalized and cultivated in the United States. The stems are long, slender, straight, mostly simple and leafy below; leaves petiolate, trifoliate, stipulate, the leaflets 1 to 3 cm. in length; flowers in terminal racemes, yellow, 5 to 6 mm. in length, with papilionaceous corolla; legumes up to 3.5 mm. in length, obovate, wrinkled, one-seeded. Odor aromatic like coumarin; taste sweet, slightly pungent and bitter.

Melilotus contains coumarin, free or combined with melilotic acid; resins and a trace of volatile oil. The drug has been used as an antispasmodic and stimulant, and in resolvent plasters and poultices.

Trifolium, or Red Clover Blossoms (N. F. 1916 to 1947) is the dried inflorescence of *Trifolium pratense* Linné, a low-growing perennial herb, native to Europe, but naturalized in the United States and extensively cultivated for fodder.

Description.—Heads globose or ovoid, from 1.5 to 3 cm. in length, consisting of numerous purplish red or pinkish brown papilionaceous flowers, up to 15 mm. in length; calyx pubescent, and with subulate teeth shorter than the corolla; odor fragrant; taste somewhat sweetish and bitter.

Constituents.—A volatile oil, coumaric acid, salicylic acid, myricyl alcohol, heptacosane, hentriacontane, sitosterol, isorhamnetin, together with several phenolic substances and glucosides, a mixture of fatty acids and a considerable quantity of sugar. Total ash, about 7.5 per cent; acid-insoluble ash, about 0.5 per cent.

Uses and Dose.—Trifolium is an alterative and a sedative. Average dose, 4 gm.

Cascara Amarga, or Honduras Bark (N. F. 1926 to 1942) is the dried bark of *Sweetia panamensis* Benham. The name Cascara Amarga is from the Spanish meaning bitter bark The plant is a tree indigenous to southern Mexico and Honduras. The dried bark is usually shipped in a matting wrapper.

Cascara amarga occurs in quills or in broken, irregular, flattened or trans- [illegible] yellowish brown, more or [illegible] ith cork more [illegible] dark reddish [illegible] ite transverse markings; interior dark brown with a light yellow zone beneath the cork and numerous yellowish groups of stone cells; the latter especially pronounced in the older bark; fracture short, hard and brittle; odor faint; taste extremely bitter and persistent.

The [illegible] groups of bast fibers associated [illegible] calcium oxalate up to [illegible] s, the individual cells u[illegible] ray tissue and parenchyma, the latter containing numerous irregular starch grains up to 25 microns in length, rarely larger, occasionally 2- to 4-compound; occasional fragments of brown cork; few slightly lignified or non-lignified fibers

Cascara Amarga contains an alkaloid, picramnine, about 3 per cent; starch, about 2 per cent; total ash, 2.5 to 6 5 per cent, most of which is acid soluble.

Cascara Amarga is used as an alterative. Average dose, 1 gm.

Adulterants.—A bark coming from the West Indies has been offered as cascara amarga or **West Indian Snake Root**. This bark does not resemble genuine cascara amarga in any respect. It is brownish black in color, about 2 mm. thick and usually in small broken pieces. Its botanical origin is not known. There has been much unintentional substitution of this drug for the genuine cascara amarga.

SENNA

Senna, or Senna Leaves (U. S. P. 1820 to date) consists of the dried leaflets of *Cassia acutifolia* Delile, known in commerce as **Alexandria**

Senna or *Cassia angustifolia* Vahl, known in commerce as **Tinnevelly Senna.** The name *Senna* is from *sena*, the native Arabian name of the drug; *Cassia* is from the Hebrew *qetsi-ah*, meaning to cut off, and refers to the fact that the bark of some of the species was once peeled off and used (the application of the name *cassia* to cinnamon barks should be noted); *acutifolia* is Latin referring to the sharply pointed leaflets and *angustifolia* means narrow-leaved. The plants are low-branching shrubs, *C. acutifolia* growing wild near the Nile River from Assouan to Kordofan;

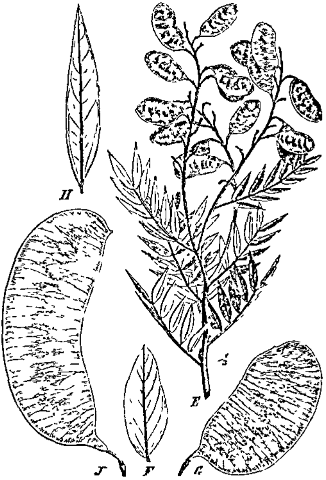


FIG. 178.—*Cassia acutifolia.* *E*, fruiting branch; *F*, a single leaflet, *G*, a pod. *Cassia angustifolia.* *H*, a single leaf, *J*, a pod. (After Taubert.)

C. angustifolia growing wild in Somaliland, Arabia and India. Most of the commercial supply of the drug is collected from plants cultivated in southern India (Tinnevelly).

Alexandria Senna is harvested in April and in September by cutting off the tops of the plants about 6 inches above the ground and drying them in the sun, after which the stems and pods are separated from the leaflets by means of sieves. That portion passing through the sieves is

then "tossed," the leaves working to the surface and the heavier fragments of stalks sinking to the bottom. The leaves are then graded and baled or packed in bags and shipped via Alexandria and Red Sea ports. This process of collection and separation accounts for the large number of broken leaves in Alexandria Senna. Tinnevelly Senna is gathered by hand and dried in the sun, carefully baled and shipped via the ports

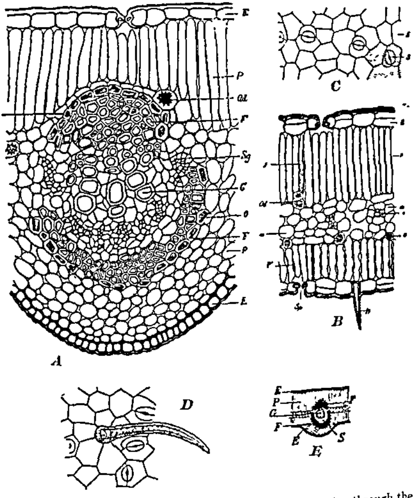


FIG. 179 —*Cassia angustifolia* (India Senna) *A*, transverse section through the middle vein showing upper epidermis (*E*), palisade cells (*P*), rosette aggregate of calcium oxalate (*Od*), monoclinic prisms of calcium oxalate (*o*), tracheæ (*G*), sieve (*Sg*), sclerenchymatous fibers (*F*), lower epidermis with rather thick-walled cells (*E*) *B*, transverse section through portion of leaf between the veins showing the absence of monoclinic prisms of calcium oxalate, the presence of palisade cells and stomata on both the lower and upper epidermis, and a hair (*H*) on the lower surface *C*, lower epidermis in surface view. *D*, upper epidermis showing stomata and a single hair. *E*, diagram of section through the middle vein, the letters corresponding to those in *A*. (After Meyer.)

of Tuticorin, Madras and Calcutta. The Tinnevelly variety is more largely used, although the Alexandrian is said to be more highly esteemed. Senna was introduced into European medicine in the ninth or tenth century by the Arabians. Its native use seems to antedate historical record. According to Isaac Judæus, a native of Egypt who lived about 850-900 A.D., senna was brought to Egypt from Mecca.

Description, Structure, and Powder.—See Figures 178, 179, 180, and the U. S. Pharmacopœia.

s
r
e
glycosides.

Standards and Tests.—Senna contains not more than 8 per cent of its stems, and not more than 2 per cent of its pods or other foreign organic matter, and yields not more than 3 per cent of acid-insoluble ash.

An assay for senna has been devised wherein the laxative effect upon mice of the unknown sample is compared to the laxative effect of the reference standard senna upon mice. A series of standard doses of each senna is injected into the stomachs of normal white mice of nearly uniform weight. The assay in full detail requires 200 mice. Each mouse is kept in a separate cage After twelve to sixteen hours, the feces are noted. Non-laxation or laxation of different intensities can be readily distinguished on the blotting paper beneath each cage. A comparison is made between the action of the reference standard and that of the unknown sample and is expressed in percentage of the reference standard.

Uses and Dose.—Senna is a laxative and a cathartic. Average laxative dose, 0 6 gm

Adulterants.—**Argel** leaves (*Solenostemma argel*, Fam. *Asclepidaceæ*) with

ngustifolia
are from
n to dark
oth, dark
brown seeds The pods contain the same active principles as the leaflets, but in much less degree.

American Senna (U. S. P 1820 to 1882) is the dried leaflets of *Cassia marilandica*, an herbaceous perennial, indigenous to the eastern and central United States and Canada, with 12- to 20-foliate leaves, yellow flowers and linear, slightly curved legumes. The laxative activity of the drug is very slight

Cassia Obovata (U S P. 1831 to 1842) is the leaflets of *Cassia obovata* Linné. The leaflets are broad and obovate and the pods are distinctly curved. The plant is native to northern Africa and the leaflets are occasionally found in the official drug. They are not as laxative in action as the official senna

Mecca Senna, or Arabian Senna, is obtained from wild plants of *C angustifolia* growing in Arabia **Aden Senna** is the leaflets of *C holosericea*, of Abyssinia, they are quite hairy and are found occasionally in the market

The leaves of other members of the *Leguminosæ* may be used like Senna, as *Cytisus purgans* of southern France, *Tephrosia apollinea* of Egypt, and *Colutea cruenta* of the Caucasus region.

The root of *Viviania esculenta* (Fam. *Geraniaceæ*), of the East Indies, contains a principle resembling cathartic acid.

Compound Senna Powder, or Compound Licorice Powder (U. S. P. 1828 to 1942; N. F. 1942 to date) *consists of a mixture of* powdered senna (180), powdered glycyrrhiza (236), washed sulfur (80), fennel oil (4), and powdered sucrose (500). The powder is weak yellow to dusky yellow in color with a fennel-like odor (see Fig. 180).

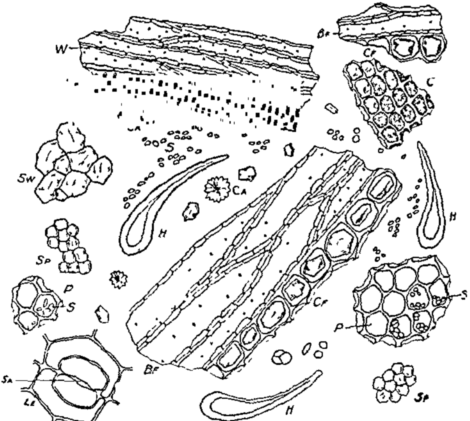


FIG. 180.—Compound Senna Powder. Fragments of Glycyrrhiza· *Bf*, bast fibers, *Cf*, crystal fibers, *W*, wood fibers, *Tb*, tracheæ having bordered pores, *C*, cork cells, filled with a reddish brown amorphous content, *Ca*, monoclinic prisms of calcium oxalate from 10 to 30 *microns* in length, *P*, parenchyma cells containing starch grains (*S*), from 2 to 20 microns in diameter. Fragments
Le, fragment of lower epidermis s
oxalate 10 to 20 microns in diam
fragments of washed sulfur, *Sp*, aggregates of spheroidal fragments of precipitated sulf
(Drawing by Hasse)

Lender

of the powder with 2 cc. of alcohol, adding 10 cc. of water
cooling and filtering, the filtrate should be of a pale yellowish brown color, which, upon the addition of a drop of *solution of potassium hydroxide*, changes to a yellowish red

USES AND DOSE.—Compound Senna Powder is a laxative and a cathartic. Average dose, 4 gm.

COPAIBA

Copaiba, or Balsam Copaiba (U. S. P. 1820 to 1942; N. F. 1942 to date) is an oleoresin derived from South American species of *Copaifera* (*Copaiba*). *Copaiba* is from the Brazilian native name *cupauba*. The plant is a tree up to 18 meters in height. The *oleoresin*, which is a physiological product, is formed in schizolysigenous cavities in the wood and seems to be a metamorphosed product of the cell walls; these cavities sometimes contain several liters of the oleoresin. The trees are tapped or boxed (see Turpentine) to the center of the tree and the oleoresin conducted directly to containers. A tree frequently yields 20 to 24 liters.

There is considerable variation in South American copaiba from different sources. The two principal varieties are: (1) **Para or Maranham copaiba** from *Copaiba langsdorfii* and *Copaiba coriacea*, which is optically levogyrate; (2) **Maracaibo or Venezuela copaiba**, obtained from *Copaiba officinalis* and *Copaiba guyanensis* which is more viscid, darker in color and dextrogyrate.

The first description of the collection of copaiba is that of Marcgrav and Piso (1648), although Petrus Martys mentions the *copei* tree as early as 1534.

It should be noted that the term *balsam* is erroneously applied. Copaiba is an oleoresin and contains neither benzoic nor cinnamic acid.

Description.—A pale yellow to yellowish brown, viscid liquid, more or less transparent and highly refractive, sometimes slightly fluorescent, having a distinct aromatic odor and a bitter, acrid, persistent taste. It is soluble in absolute alcohol, chloroform, ether and carbon disulfide.

Constituents.—Volatile oil, resin acids, and a small quantity of a bitter principle.

It is a diuretic,

a … cc.

… l, olive oil, rosin,

gu … ced with copaiba and may be detected by the pharmacopœial tests.

Th …

co …

to …

soluble in alcohol, ether or carbon disulfide It is levorotatory (−7 to −35).

volatile solvents

Gurjun Balsam

Hardwickia sp. Its oil is dextro-

Copal is a fossil resin or is found exuding from various leguminous plants. Its medicinal properties resemble those of copaiba but it finds its principal usage in the manufacture of varnishes.

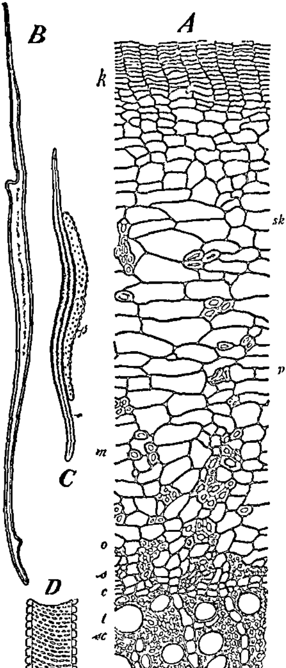


FIG. 181 —Peruvian Rhatany *A*, transverse section showing cork (*k*), a group of bast fibers (*sk*), parenchyma of cortex (*p*), medullary-ray cells of inner bark (*m*), cambium (*c*), tracheæ (*t*), wood fibers (*sc*), wood parenchyma (*hp*), medullary rays one cell in width (*m*); *B*, an isolated bast fiber, *C*, a wood fiber with neighboring parenchyma cells which are somewhat elongated and have somewhat thickened, porous walls; *D*, portion of a trachea. (After Meyer.)

Damar, Dammar, or Resin Damar as a mounting medium (N. F. 1942 to date) is the resinous exudate from *Shorea Wiesneri* Schiffner (Fam. *Dipterocarpaceæ*).

[illegible] the Philippines where the [illegible] inded or irregular, friable [illegible] It is insoluble in water, [illegible] chloroform, ether, carbon disulfide and xylene. Its principal use is in varnishes and lacquers, occasionally in medicinal plasters. A filtered solution in xylene, concentrated to a suitable consistency, is used for mounting microscopic specimens.

Krameria, or Rhatany (U S. P. 1831 to 1916, 1926 to 1936; N F. 1916 to 1926, 1936 to 1947) is the dried root of *Krameria triandra* Ruiz et Pavon, known in commerce as Peruvian Rhatany; or of *Kramaria Argentea* Martius (1894 to 1947), known in commerce as Para or Brazilian Rhatany, or of *Krameria tomentosa* Saint Hilaire (*K. Ixina* Linné), known in commerce as Savanilla Rhatany (1882 to 1926) *Kramaria* was given in honor of J. G. H. and W. H. [illegible] *argentea* is found mostly in Brazil, being shipped from Para or Rio de Janeiro, [illegible]

[illegible] Rhatany is about one-third of the diameter of the root; that of Para about one-half, the wood is orange color, the bark dark red For structure see Figure 181

Powdered krameria is moderate brown, inodorous and very astringent, starch grains are simple or few-compound, usually with a central cleft and up to 35 microns in diameter, calcium oxalate in prisms up to 100 microns long and occasional microcrystals; bast fibers long, wavy, much attenuated, and non-lignified; wood fibers numerous, spindle-shaped, thick-walled, but only slightly lignified; tracheæ with simple or bordered pores (See Fig 181)

Krameria contains from 8 to 20 per cent of tannin; krameric acid, starch; [illegible] cent.

Krameria more than 1 cm in thickness should be rejected.

[illegible]

Kr[illegible] ro[illegible] krameria.

ACACIA

Acacia or Gum Arabic (U. S. P. 1820 to date) is the dried gummy exudation from the stems and branches of *Acacia senegal* (Linné) Willdenow, or of some other African species of *Acacia*. *Acacia* is the

Greek *akakia*, coming from *ake*, meaning pointed and referring to th thorny nature of the plant; *senegal* refers to its habitat. The nam "gum arabic" seems to be a misnomer, since very little acacia is pro duced in Arabia and none is exported. It may have had its origin i the fact that the drug was extensively used by the early Arabian physi cians.

Acacia plants are thorny trees about 6 meters in height growing in Kordofan in the Anglo-Egyptian Sudan and in Senegambia (Senegal). Most of the official drug comes from cultivated trees in Kordofan. The trees are tapped by making a transverse incision in the bark, peeling the bark both above and below the cut, thus exposing an area of cambium 2 to 3 feet in length and 2 to 3 inches in breadth. In two or three weeks the tears of gum formed on this exposed surface may be collected. The formation of the gum may be due to bacterial action or to the action of a ferment. No trace of metamorphosed cell walls are found in the gum, therefore it must be formed from cell contents. The gum is occasionally exposed to the sun to bleach it. Numerous minute cracks often form in the outer portion of the tears during the bleaching process, thus giving them a semi-opaque appearance. The tears are garbled and graded by hand, then packed and shipped via Port Sudan. Acacia has been an article of commerce since most remote times. The tree, together with heaps of gum, is pictured during the reign of Rameses III, and in later inscriptions. It was exported from the Gulf of Aden seventeen hundred years before Christ. Theophrastus mentions it in the third century B.C. under the name of "Egyptian Gum." During the Middle Ages it was obtained from Egypt and Turkey. The west African gum (Senegal) was imported by the Portuguese during the fifteenth century.

DESCRIPTION.—In spheroidal tears or angular fragments of variable size; externally whitish or yellowish white with numerous minute fissures; translucent; very brittle, with a glass-like sometimes iridescent fracture; nearly [illegible] cia is insoluble in alcohol but almost com- [illegible] water. [illegible] in cold water, forming a sticky paste and [illegible] grains or vegetable tissues. [illegible] which is composed of [illegible] ssium and magnesium. [illegible] side-l-arabinose. The residue is compose [illegible] in the proportion of 3 to 1. Methylation [illegible] nucleus is composed of nine galactose residues and [illegible] so linked as to give a branched chain structure having four terminal or end residues but only one reducing group. These terminal residues are composed of uronic groups and galactose in the ratio of three to one Acacia also contains an oxydase and from 12 to 15 per cent of water.

STANDARDS AND TESTS.—Acacia yields not more than 1 per cent of water-insoluble residue, not more than 4 per cent of total ash, not more than 0.5 per cent of acid-insoluble ash, and not more than 15 per cent of moisture. The addition of 0.2 cc. of diluted lead subacetate solution to 10 cc. of a 2 per cent cold aqueous solution of acacia immediately produces a flocculent, curdy white precipitate. A 10 per cent aqueous solution of acacia should show but slight levorotation. One-tenth cubic centimeter of ferric chloride T.S. added to 10 cc. of a 2 per cent aqueous solution of acacia should show no blackish coloration

nor blackish precipitate (tannin-bearing gums). Iodine T.S. added to a 2 per cent aqueous solution of acacia which has been previously boiled and cooled should produce no bluish or reddish color (starch or dextrin).

USES.—Acacia is a demulcent. It is used also as an emulsifying agent and in making mucilage.

more frequently mixed with inferior gums, especially the mesquite gum

ALLIED PLANTS.—Gums with a brown or red color are obtained from *A. arab-*

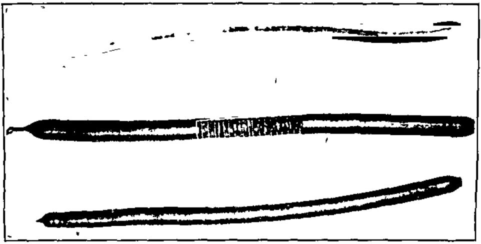


FIG. 182.—Cassia Fistula × ½ the middle fruit is partially cut away to show the transverse partitions and seeds (Photo by Adamson)

Mesquite Gum is obtained from *Prosopis juliflora*, of the southern United States and Mexico. The tears are nearly smooth, light yellowish brown to dark

as an emulsifying agent.

Ghatti Gum or Indian Gum is an exudation from the wood of *Anogeissus latifolia* (Fam. *Combretaceæ*), a tree indigenous to India and Ceylon. It occurs in yellowish white tears with a dull, rough surface and a vitreous fracture. It is entirely soluble in cold water, forming a very viscous mucilage. A 1 per cent solution of Ghatti gum gives a precipitate with a 10 per cent tannic acid solution This is a distinction from acacia

CASSIA FISTULA AND TAMARIND

Cassia Fistula Pulp also was recognized in the U. S. P. 1831 to 1863.

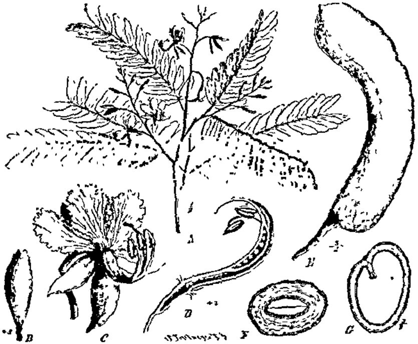
The legume is nearly straight, indehiscent, cylindrical, 25 to 50 cm. in length,

15 to 20 mm. in diameter; e
the base rounded and som
versely striate, on one sic
pericarp hard and woody
numerous compartments about 5 mm. in length, each containing brownish

senna and related plants.

Tamarind (U. S. P. 1820 to 1916; N. F. 1916 to 1936) is the partially dried, ripe fruit of *Tamarindus indica* Linné, deprived of the brittle outer portion of the pericarp and preserved in sugar or syrup.

Tamarind Pulp also was recognized in the U. S. P. 1831 to 1863.



... pinnate leaves; B, flower ... of the seed. (After Taubert.)

The tamarind tree is indigenous to Africa and is cultivated in the West and East Indies, whence the two chief commercial varieties are obtained. In the West Indies, the epicarp ... from the legumes and boiling syrup is poured over the pulp an... into a mass with sugar ... about 1 pound capacity.

West Indian tamarind is usually a blackish brown mass, with a distinct odor and a strongly acidulous, sweet taste, in which are embedded numerous seeds enclosed in a loose, tough membrane

East Indian tamarind occurs in blackish cakes, containing less sugar and more acids.

Tamarind contains tartaric, citric and malic acids (10 to 20 per cent); organic acid salts, invert sugar, 32 to 42 per cent; total ash about 3.6 per cent; acid insoluble ash about 0.25 per cent The drug is used as a mild laxative and refrigerant.

PEANUT

Peanuts are the ripe fruit or seed of *Arachis hypogæa* Linné. The plant is a low annual herb with imparipinnate leaves and yellow papilonaceous flowers; it is native to Brazil but is extensively cultivated in the southern United States, China and other semi-tropical localities. The fruit is not a true nut, but the immature pod penetrates into the soil and the fruit ripens underground. It contains from 1 to 6 reddish brown seeds.

The green tops of the plants form an excellent hay, **Peanut Hay**, but when the fruits are fully ripened, the value of the hay is much reduced. When ripe the plants are raked from the soil with the fruits into windrows. When dry the pods are machine-separated and sacked for shipment; or the dried plants are threshed to separate and clean the seed. For human consumption the fruit are roasted, then passed between rollers and the seed are separated. The kernels

Peanut Oil (U S. P. 1947 to date) is the fixed oil obtained by cold pressure from the peeled ripe seed of one or more of the cultivated varieties of *Arachis hypogæa* Linné.

Peanut Oil is a yellowish liquid with a slight nut-like odor and a bland taste For constants and tests of identity and purity, see the U. S. Pharmacopœia.

Peanut oil consists chiefly of olein with small percentages of several other glycerides. It closely resembles olive oil and the Pharmacopœia permits its ... Its principal ... paints, but is ... excellent, firm, ... soap.

Peanut Oil Cake is a valuable stock food

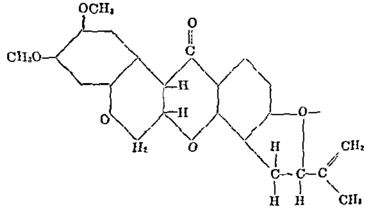
ROTENONE

Rotenone is one of the insecticidal principles obtained from the root of *Derris elliptica* Bentham, *Derris malaccensis* Bentham, *Derris negrensis*, *Lonchocarpus nicou* DC, *Lonchocarpus utilis* Kleinh., *Lonchocarpus chrysophyllus* Kleinh., *Tephrosia toxicaria*, *Tephrosia virginiana* Linné, or other species of *Derris*, *Lonchocarpus* or *Tephrosia*

Derris Root or Tuba Root appears in commerce from British Malaya, the Netherlands Indies and the Philippines, mostly from cultivated plants. About 2 5 million pounds of derris root were imported into the United States in 1939. The genus *Lonchocarpus* includes sev... Mexico, Central and South America, and to ... Australia The commercial root is known as C... or that from Amazonian Brazil ... in 1939 The genus *Te*... recent interest, is the ... eastern and southern United States.

These roots may contain rotenone, deguelin, toxicarol or tephrosin, compounds structurally related, and having insecticidal properties The roots are usually ... tone-soluble ... be present, ... or 20 per ... per cent of rotenone, and *Lonchocarpus* species ... cent of rotenone; *Tephrosia* species contain about 0.5 per cent of

Rotenone is extracted by means of suitable organic solvents, and crystallized. It is a white, odorless compound having the following formula:



... Its melting point ... ts ... in water.

Rotenone is used to a limited extent in ... ations used on the skin (powders, ointments, etc.), where ... With the discovery of DDT, however, th... extent. Rotenone is used as a general insecticide in sprays or dusts. The commercial dusting powders may contain pure rotenone, acetone extract or the powdered roots admixed with kaolin, talc, clays, ground walnut shell or other inert material so as to contain a concentration of rotenone of about 1 per cent.

Rotenone is exceedingly poisonous to insects and to fish but is practically harmless to higher animals Goldfish die in water containing 1 part of rotenone in 20 million parts of water, but the lethal oral dose for dogs is 300 mg. per kilo of weight. Rotenone dusts are therefore quite safe for dusting drug plant crops as well as vegetable crops.

HEMATOXYLON

Hematoxylon or Logwood (U. S. P. 1820 to 1916; N. F. 1916 to 1936) is the heartwood of *Haematoxylon campechianum* Linné, a tree indigenous to Central ...

... taste sweet, astringent; the wood imparts to water a violet ... -lin. The wood contains much tannin (gallotannin), some resin and hematoxylin. The drug has been used as an astringent.

Hematoxylin (U. S. P. 1905 to 1926; 1936 to date; N. F. 1926 to date) is in colorless or pale yellow prisms, and present in logwood to the extent of 10 to 12 per cent. It is sparingly soluble in water, readily soluble in hot water and in alcohol. It is used as an indicator, a stain for microscopic sections, and in the manufacture of inks and dyes.

Hematein (U. S. P. 1916 to date; N. F. 1936 to date) is an oxidation product of hematoxylin. It forms in the wood on exposure to air so that the chips become dark red and have a greenish metallic luster. It forms rapidly when hematoxylin is dissolved in alkaline (ammonia) solutions.

It occurs as yellowish brown crystals with a yellowish green metallic luster. It is insoluble in water, alcohol, chloroform, or ether, but dissolves in alkaline solutions with a red color. It is used as an indicator and in nuclear stain for cytologic sections.

Fermented (oxidized) logwood has an extensive use as a textile dye. Note that the dye value of each of the above logwood products is due to the hematein.

Brazil Wood (U. S. P. 1894 to 1916) is obtained from *Cæsalpinia echinata* Lamarck, and contains the principle known as **brazilin**, which is colorless when first extracted, but assumes a red color on exposure to the air. It was used as an indicator in the Pharmacopœia.

Fig 184 —Hematoxylin: monoclinic tabular crystals from aqueous solution.

Sappan or False Sandalwood is obtained from *Cæsalpinia Sappan* Linné of

SOY BEAN

Soy Bean is the ripe seed of *Glycine Soja* Sieb et Zucc, an important food and forage crop. The plant is an annual with trifoliate, hairy leaves; rather inconspicuous, pale blue to violet-colored flowers, and broad pods containing 2 to 5 seeds. The seeds are more or less compressed, spheroidal or ellipsoidal and vary in color from nearly white to yellow-green or brownish black. The seed contain about 35 per cent of carbohydrates, up to 50 per cent of protein substances, up to 20 per cent of fixed oil, and the enzyme urease.

Soy beans are used medicinally as a food for diabetics, and, especially in China, as a general food for humans and stock **Soy Bean Hay** is a valuable stock food.

Soy Bean Meal, as a reagent (N. F. 1942 to date) is the flour sifted from the decorticated, ground seed of *Glycine Soja*, deprived of fat. It is used for the detection of urea nitrogen in blood serum by the enzymatic action of the urease in the soy bean meal.

Soy Bean Oil is obtaine
The oil contains 50 per c
acid, hence it is a drying
in the manufacture of varnishes, insulators, etc.

Soy Bean Cake, the residue after pressing out the oil, has a high value as a stock food. It not only contains a large amount of protein and some oil, but the 5 per cent of ash consists largely of potassium and phosphorus. Fiber is but 2 to 5 per cent.

Baptisia, or Wild Indigo Root (U. S. P. 1831 to 1842; N. F. 1916 to 1936) is the dried root of *Baptisia tinctoria*, a perennial herb growing in the eastern United States and Canada. The drug is gathered in the fall, and consists of a warty crown, branching into stem remnants and buds, and bearing numerous roots which are 0.5 to 4 cm. in thickness, externally brown, longitudinally wrinkled, occasionally spirally twisted, somewhat scaly, and with long, wiry, some ... the inner surface
is w
wood
B
solul
It also contains baptin, which forms acicular crystals and is purgative; and about 6 per cent of baptisin, a crystalline glucoside. Total ash about 2.5 per cent, acid-insoluble ash about 0.5 per cent.

In large doses it is an emetic and cathartic.

Galega, or European Go ... dried flowering tops of *Galega officinalis*,
cultivated to some extent.
of the flowering of the plant, and carefully dried.

The stem is cylindrical, hollow, from 2 to 3 mm. in diameter, pale green or greenish brown, distinctly longitudinally ribbed or furrowed; the leaves are
odd-pinn
from 10
greenish
white or
bitter

Galega contains a bitter principle and tannic acid. Total ash about 10 per cent; acid-insoluble ash about 0.5 per cent

Galega is claimed to be a galactagogue. It is a mild astringent and a tonic.

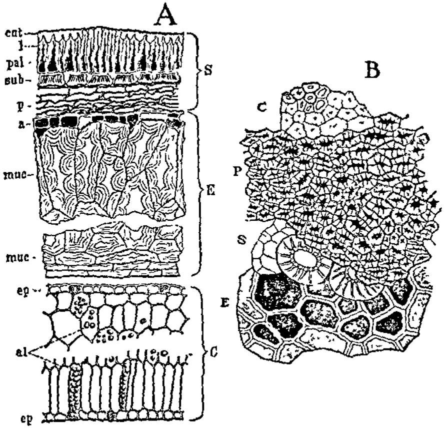
Cowhage, Dolichos, or Mucuna (U. S. P. 1820 to 1882) consists of the hairs of the pods of *Mucuna pruriens*, a climbing plant growing in the East and West Ind ... serrate
on ... ible
itel ... ved
as ... act

Catechu, Black Catechu, or B
prepared from the heartwood o
Burma. The wood is extracted
ated to a syrupy consistency and allowed to harden. The drug occ... reddish black, masses, with fragments of leaves or mats upon the outside; it is reddish black, somewhat shiny, brittle, more or less porous, and has a slight odor and an astringent and sweetish taste. It contains about 25 per cent of phlobatannin called catechutannic acid and is used as an astringent.

Black catechu is also extracted from the wood of *Acacia suma*, of India
The barks of a number of species of *Acacia* growing in Australia, and known

as wattle barks, are used in the preparation of an extract resembling black catechu. The tannin of *Acacia arabica* and of several species of *Cæsalpinia*

.he bark of *Eugenia smithii* xtract is obtained from the one of the *Meliaceæ* of the



palisade cells with small lumina, *P*, palisade cells with thick radiating porous walls and large lumina, *S*, subepidermal or column cells and parenchyma, *E*, cells of endosperm containing aleurone grains (*A*, after Winton, *B*, after Tschirch)

Mangrove Extract is prepared from the bark of the red variety of *Rhizophora mangle* or *R mucronata* (Fam. *Rhizophoraceæ*) and contains about 70 per cent of tannic acid It is sometimes sold a
with solutions of ferric salts, a reddish
sulfate and ammonia; a reddish brown
cipitate with lime water, darkened by excess, and a slight reddening with a solution of stannous chloride and hydrochloric acid. It apparently belongs to the same class of tannins as hemlock, oak, rhatany and canaigre.

Fenugreek is the dried ripe seed of *Trigonella fœnum-græcum*, an annual herb indigenous to the Mediterranean region and extensively cultivated in southern Europe, northern Africa and India.

The seeds are oblong-flattened or rhomboidal; from 3 to 5 mm. in length; externally light to dark yellowish brown; hard, heavy, and pebble-like; the odor is distinct, resembling that of elm bark, and the taste mucilaginous and slightly bitter.

The structure is shown in Figure 185.

Fenugreek contains about 50 per cent of
It is extensively used as a nutrient for sto
mulcent and emollient, usually in combina
cially in veterinary medicine.

Alfalfa is the overground portion of *Medicago sativa* and is extensively cultivated as a cattle food. **Alfalfa Hay** when well dried and ground to a fine powder constitutes **Alfalfa Meal**, which is used to some extent in human food and very extensively in mixed feeds for cattle and fowl. The plant is rich in proteins and certain vitamins.

Abrus, Jequirity or Wild Liquorice Seed is the seed of *Abrus precatorius*, a climbing shrub common to tropical and subtropical countries of both hemispheres.
precatoriu
are used
in length,
portion s
black; te

heating to 85° C Recent researches show it to be composed of
(α-phytalbumose) and abrusglobin The seed also contains an enzyme, abric acid and a coloring principle.

The roots are known as **Wild or Indian Liquorice** and contain 1.5 per cent of a substance resembling glycyrrhizin. They also contain 8 per cent of an acrid resin and a small quantity of an alkaloid, abrine, which precludes the root being substituted for glycyrrhiza. The leaves yield about 10 per cent of glycyrrhizin. Owing to their toxic properties, care should be exercised if the seeds are used by children. Abrus is an irritant to mucous membranes, occasionally used b

Rob
tree.
robin,

Jamaica Dogwood is the root bark of *Piscidia erythrina*, a tree of the West Indies. The bark has long been used for stupefying fish. It contains piscidin and piscidic acid and has been employed in medicine as a narcotic, analgesic and soporific.

Loco-Weed (*Astragalus crotalaria*), growing in California, Nebraska and Texas, is poisonous to cattle, horses. etc.. causing a spinal tetanic reaction.

Scarlet Runner Bean, the fruit *Phaseolus* is largely used as a food, both in the form of lowered. It
the ancient classical name for the ous.
has been stated that the roots of this plant are narcotic and po
Erythrophlœum guineense, a
s been employed by the
r witchcraft and sorcery,
also enters into the com-
nical examination of the
erythrophleine. Neither
in a crystalline state.

GERANIACEÆ, OR GERANIUM FAMILY

This is a small family of about 500 species, native to temperate climates and most abundant in South Africa. The flowers are perfect, regular 5-merous and hypogynous. The fruit is an elastically dehiscent capsule, separating with its long styles from the axis.

Geranium, or Cranesbill (U. S. P. 1820 to 1916; N. F. 1916 to 1936) is the dried rhizome of *Geranium maculatum,* a perennial herb indigenous to Canada and the eastern and central United States The rhizome is collected in late summer or early autumn and is horizontal, cylindrical, tuberculate, or irregularly curved, 2.5 to 10 cm. in length, 3 to 15 mm. in diameter; externally it is dark brown, wrinkled, the upper and side portions with numerous buds or circular [illegible] an astringent.

LINACEÆ, OR FLAX FAMILY

A small family of herbs and shrubs comprising about 9 genera and 150 species, having perfect, regular, 4- to 6-merous, hypogynous and nearly symmetrical flowers. The fruit is usually a capsule, containing 1 to 2 seeds in each locule, there usually being twice as many locules as there are styles. Of special anatomical interest is the mucilaginous epidermal layer in the seeds and leaves of *Linum.* Calcium oxalate is secreted only in the form of solitary crystals. The non-glandular hairs are of the unicellular type. Glandular hairs, when present, always have a multicellular stalk. The tracheæ usually have simple pores and the sclerenchymatous fibers are generally marked by bordered pores.

LINSEED

Linseed, or Flaxseed (U. S. P. 1920 to 1947; N. F. 1947 to date) is the dried ripe seed of *Linum usitatissimum* Linné. The generic name *Linum* is from the Latin *linea,* meaning thread, and refers to the use of the flax fibers; *usitatissimum* is from the Latin and means "most useful." The plant is an annual which is cultivated in all temperate and tropical regions either for the fiber (flax) or for the seed. With the possible exception of cotton, perhaps no plant is of greater economic value or of wider geographical distribution. The useful products it yields may be tabulated as follows:

Flax Plant
- Stem
  - Bast fibers → Linen thread → lace, cloth, rugs, toweling, lawn and other fabrics
  - Straw → pressed into sheets for building insulation, pulp for paper, etc
- Seed
  - Oil → paints, varnishes, linoleum, oilcloth, printers' ink, soaps, etc (70,000,000 gals. produced in U. S annually)
  - Oil cake → cattle feed (about 600,000 tons produced in U S. annually)

The annual crop is harvested when the fruits are fully mature, usually with the "combine" which separates and cleans the seed in the field. The oil is removed from the seed by expression.

The economic use of flax antedates all historical record. Seed and fabric made from the fibers of flax have been found in the remains of the Swiss Lake dwellings and the weaving of flax into cloth is illustrated on the Egyptian tombs. Mummy cloth dating back to at least 2300 B.C. is made from flax. The use of the seeds both as a food and medicine are mentioned by historians as early as the seventh century B.C. Charlemagne promoted the growth of flax in northern Europe.

Considerable flax is grown in North and South Dakota, Minnesota, Montana, Kansas, Southern California, Canada, Nebraska, Missouri, Wyoming, Wisconsin, Iowa in the United States and in many other countries. The U. S. production is about 30 million bushels of seed annually, and about 15 million bushels are imported from Canada, Europe and South America.

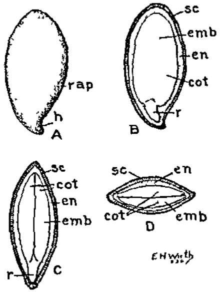


FIG. 186

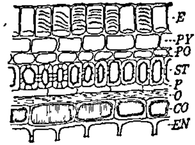


FIG. 187

...section through the broad diameter ...he seed, *D*, transverse ...nbryo; *en*, endosperm:

...vith small lumina and very thick outer wall showing mucilage lamellæ, *PY*, *PO*, parenchyma cells; *ST*, stone cells; *P*, parenchyma beneath stone cells, *O*, obliterated cells of the hyaline layer; *CO*, pigment cells with reddish brown contents; *EN*, endosperm.

DESCRIPTION AND STRUCTURE.—See Figures 186, 187, 188 and the National *Formulary*.

CONSTITUENTS.—Fixed oil, 30 to 40 per cent; proteins, about 25 per cent; mucilage; total ash, 4 per cent; acid-insoluble ash, 0 3 per cent.

...ins not more than 2 per cent of other seeds ... not less ... yields not more than 6 per cent of ash, ... at least 9S per cent ...le, ether-soluble extractive, ... practically free from starch; and upon defatting

as a poultice.

Allied Plant.—In False Flax (*Camelina sativa*) of Europe the sclerenchymatous fibers are replaced by broad, short stone cells, and the epidermal cells on the addition of water eject a central column of mucilage.

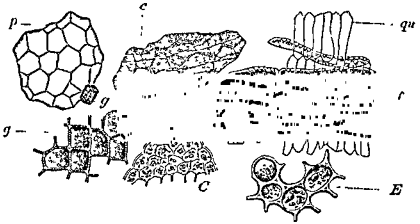


Fig 168 —Linseed or Flaxseed Meal yellow with numerous brown fragments, *P*, epidermis with mucilaginous epidermal cells, *c*, epidermal cells with broken cutinized layer, *E*, subepidermal cells of a yellowish color, *f*, sclerenchymatous fibers, 100 to 250

Moeller)

Linseed Oil, Flaxseed Oil, or Raw Linseed Oil (U. S. P. 1820 to 1947; N F. 1947 to date) is the fixed oil obtained from linseed. In the preparation of linseed oil the seeds are first crushed to break the seed coats. The crushed seeds are then subjected to hydraulic pressure, usually accompanied by heat and the oil removed by expression.

Description.—A yellow oily liquid having a peculiar odor and a disagreeable taste When exposed to the air, it gradually thickens, darkens in color,

ated acids· myristic, stearic and palmitic

Standards.—For use in paint, linseed oil is boiled with driers, such as litharge, which form metallic salts. These salts hasten the drying of the oil. Linseed

USES.—Linseed Oil is a demulcent and a laxative when taken internally. It is applied externally, usually in the form of **Linimentum Calcis** or **Carron Oil** (U. S. P. 1820 to 1936; N. F. 1936 to date), for burns, scalds, etc.

Flaxseed Meal or Linseed Meal (U. S. P. 1863 to 1882) is usually mentioned in the official monograph, though a separate monograph for it is no longer included in the Pharmacopœia. It is commonly prepared from the linseed "oil-c ... , though up to 10 per cent (... latile solvents. It is used ...

Fla ... rye or wheat grains, unintentionally mixed with the flaxseed or because the meal was shipped in *second-hand flour sacks. To prevent infestation with maggots keep flaxseed* meal in well-closed containers containing a small amount of carbon tetrachloride.

ERYTHROXYLACEÆ, OR COCA FAMILY

This is a very small family, represented by 2 genera, the more important of which is *Erythroxylon*. They are mostly tropical shrubs with entire leaves and 5-merous flowers, and the fruit is a 1-seeded, reddish drupe resembling that of dogwood. The anatomy of the plants of this family closely resembles that of the *Linaceæ*. Of especial interest is the development of papillæ on the dorsal surface of the leaves. This is found in most species of *Erythroxylon*.

COCA

Coca or Coca Leaves (U. S. P. 1882 to 1916) is the dried leaves of *Erythroxylon Coca* Lamarck, known commercially as Huanuco Coca (U. S. P. 1882 to 1916), or of *Erythroxylon truxillense* Rusby, known commercially as Truxillo Coca (U. S. P. 1905 to 1916), or of *E. novogranatense* (Morris) Hieron, known commercially as Peruvian Coca (never official).

The plants are shrubs or small trees attaining the height of about 2 meters, indigenous to Peru (*E. truxillense*) and Bolivia (*E. coca*), and cultivated not only in these countries but also in Java (*E. truxillense*), and to some extent in Ceylon. ... alluding to the cc ... *uxillense* is from ... plants

Most of the pr ... re grown at an altit ... he collected from th ... st third time in the ... ru *of it being chewe* ... exports a considerable quantity of crude cocaine.

Coca leaves were highly valued by the natives long before the Spanish conquest, the tree being known as "The Divine Plant of the Incas." Monardes published an extensive article on the drug in 1569. The natives chew the leaf, either as such or mixed ... travel great distances, often with heavy loads, ... hout any but the most meager food ratio ...), but until 1884, coca was considered as ... that year Koller discovered its local anesthetic properties.

Huanuco Coca Leaves are oval, obovate or elliptical, 3 to 7 cm. in length, *2 to 3 cm. in breadth (Fig. 189), with an acute*, slightly mucronate apex, an acute base, and an entire, somewhat revolute margin. The upper surface is dark green, glabrous, and the under surface yellowish green and distinctly undulate with numerous minute papillæ. A parallel line about 4 mm. from the midrib on either side and extending from the base to the summit is often noted.

The texture is somewhat coriaceous, the odor distinct, and the taste bitter,

curved

Javanese Coca Leaves resemble Truxillo coca and are employed for the manufacture of cocaine in Holland.

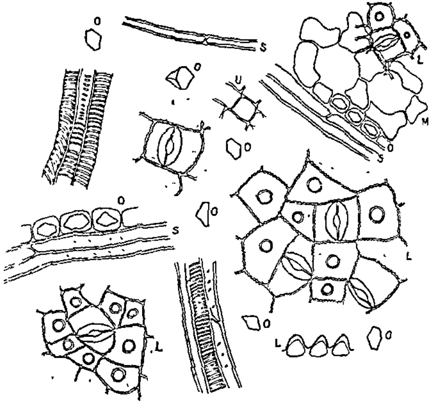
FIG 189.—Flowering branch of *Erythroxylon coca*, showing the parallel lines on either side of the midrib, which are not true veins, but due to an extra development of hypodermal cells in this region. (After Reiche)

and calcium oxalate Young coca leaves contain more than twice as much total alkaloids as the older leaves

Coca is used as a stimulant of the central nervous system in neurasthenia,

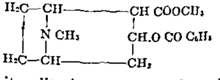
Cocaine (U. S. P. 1905 to date) is an alkaloid obtained from t leaves of *Erythroxylon Coca* Lamarck and other species of *Erythroxylo* or by synthesis from ecgonine or its derivatives.

Cocaine Hydrochloride (*U. S. P. 1894* to date) is the hydrochloric of the alkaloid cocaine.



composed
or-

Cocaine is obtained by extracting the leaves with dilute acid, or by treating them with lime and extracting with an organic solvent. The alkaloids may be purified by transferring from one solvent to another and crystallization. Cocaine is the methyl ester of benzoyl-ecgonine:



When hydrolyzed it splits into ecgonine, benzoic acid and methyl alcohol. Cinnamyl-cocaine splits into ecgonine, methyl alcohol and cinnamic acid; while α- and β-truxilline split into ecgonine, methyl alcohol and α- and β-truxillic acids. (The truxillic acids are isomeric dicinnamic acids.) Very often the complete mixture of alkaloids is

hydrolyzed, by boiling with hydrochloric acid and the ecgonine hydrochloride thus formed converted into the free base. The ecgonine is benzoylated and methylated, thus forming a larger yield of cocaine.

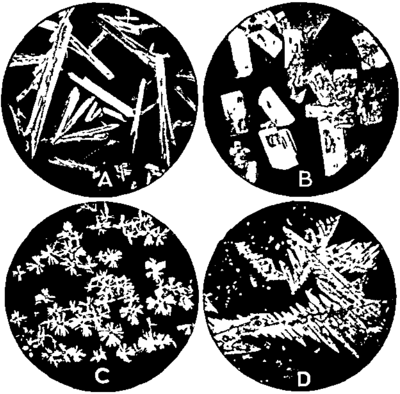


FIG 191 —Cocaine *A*, monoclinic crystals of cocaine, *B*, orthorhombic crystals of cocaine hydrochloride, *C*, monoclinic crystals of cocaine hydrochloride and palladous chloride, *D*, skeleton aggregates of cocaine hydrochloride and palladous chloride.

DESCRIPTION AND TESTS OF IDENTITY AND PURITY —See Figures 191, 192, 193 and the U. S Pharmacopœia.

USES AND DOSE.—Cocaine and cocaine hydrochloride are cerebral stimulants when taken internally, large doses, however, being narcotic. Externally they are local anesthetics Average dose, 15 mg

Synthetic Local Anesthetics have been produced, with a view of increasing . Some of them are
n epinephrine. They
action of cocaine is
nitrogen-containing
basic group.

for optical application.

Amylcaine Hydrochloride (NNR) is like cocaine hydrochloride but non-mydriatic.

Butacaine Sulfate or **Butyn Sulfate** (NNR; U. S. P. 1942 to date) is somewhat more toxic than cocaine, but is useful for surface anesthesia.

Diothane Hydrochloride (NNR) is like cocaine but somewhat more toxic, three times as toxic as procaine.

Eucaine Hydrochloride or **Betaeucaine Hydrochloride** (U. S. P. 1916 to 1942; N. F. 1942 to date) is much less toxic than cocaine and is used extensively in the eye and on mucous surfaces.

[illegible] To 0.5 cc. of a 1 per cent solution of [illegible] while stovaine and euphthalmine give no precipitates. None of the [illegible] by the cocaine substitutes resemble the cocaine chloroplatinate in any way. (After Seitor and Enger.)

Phenacaine Hydrochloride or **Holacaine Hydrochloride** (NNR; U. S. P. 1936 to date) is more rapid in action, especially in the eye, than cocaine.

Tutocaine Hydrochloride or **Butamin** (NNR) is used for surface anesthesia in low [illegible] it anesthetic effect

PROC[illegible] ency to dilate the much l[illegible] blood-vessels, epinephrine is frequently used with the an[illegible]etic in the hypodermic injection. Relatively ineffective for surface anesthesia.

Apothesine Hydrochloride (NNR) is slower in action and more toxic than procaine, but less toxic than cocaine.

Larocaine Hydrochloride (NNR) is like procaine, useful in surface and infiltration anesthesia, quick in action and of long duration.

Metycaine Hydrochloride (NNR) is useful in surface anesthesia; subcutaneously it is three times as toxic as procaine.

Nupercaine Hydrochloride or Dibucaine Hydrochloride (NNR) is very powerful and toxic; used in doses about one-tenth of those of procaine hydrochloride

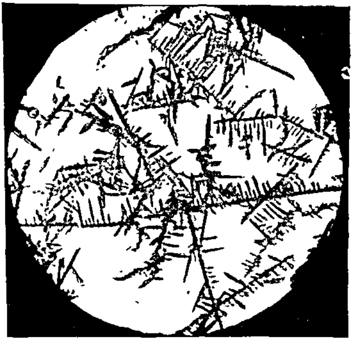


FIG 193.—Crystals of cocaine-chloro-aurate. To 1 cc of a dilute solution (1 300) of cocaine are added 3 drops of gold chloride test solution, avoiding shaking as in the case of the platinum chloride test. A precipitate immediately forms and slowly changes from the amorphous into the crystalline state Under the microscope, the crystals resemble fern-fronds, generally with a stellate arrangement In dilutions of 1 12,000,

with beta-eucaine, acoine and holocaine Euphthalmine gives no precipitate (After Seiter and Enger)

Procaine Hydrochloride or Novocaine Hydrochloride (NNR; U. S. P. 1926 to date) is less toxic than cocaine and the effect is less sustained.

Procaine Borate (NNR)
Procaine Nitrate (NNR).

Tetracaine Hydrochloride, Pontocaine Hydrochloride or Amethocaine Hydrochloride (NNR, U. S. P 1942 to date) is like procaine in action but effective in somewhat lower concentration.

irri

in

ointment or suppositories.

Butyl Aminobenzoate or Butesin (NNR; U. S. P. 1942 to date).

Butesin Picrate (NNR).

Ethyl Aminobenzoate, Anesthesin or Benzocaine (NNR; U. S. P. 1926 to date).

Orthoform-New (NNR) is used mostly externally in wounds.

ZYGOPHYLLACEÆ, OR CALTROP FAMILY

The plants are mostly herbs and shrubs which are widely distributed in warm-tropical regions. The leaves are mostly opposite, pinnate and stipulate. The flowers are perfect, regular and mostly 5-merous. The fruit is usually capsular. The hairs are usually simple and unicellular, occasionally there is a metamorphosis of the wall to form a resinous excretion. True glandular hairs do not occur in the plants of this family. Mucilage cells and tannin-secreting cells are occasionally present. The tracheæ usually have simple pores and in *Guajacum* are filled with resin. Calcium oxalate is secreted in the leaves in the form of rosette aggregates and in the axis in solitary crystals.

GUAIAC

Guaiac Wood or Lignum Vitæ (U. S. P. 1820 to 1905; N. F. 1916 to 1926) is the heartwood of *Guajacum officinale* Linné, or of *Guajacum sanctum* Linné. The name *Guajacum* is from the Spanish *guayaco*, the native Haitian name of the plant; *officinale* means used or found in the workshop of the pharmacist; *sanctum* means holy, sacred or consecrated. The plants are small evergreen trees, *G. officinale* being found in Colombia, Venezuela and in the West Indies, while *G. sanctum* is found in Cuba, Haiti and the Bahamas

Guaiac wood is extremely hard and is used in the manufacture of mallets and
other wooden articles where harc
in the form of dark brown or gr
cent of resin and also saponins.

Guaiac or Guaiac Resin (U. S. P. 1820 to 1926; N. F. 1926 to date) is the resin obtained from guaiac wood by boiling the chips with water, the melted resin rising to the top; it is then removed from the water, strained and dried. Formerly, a log was bored longitudinally and ... the end
heated in a sloping position, ... ningo in
of the log. Guaiac was intr
1526 and became a popular

DESCRIPTION – ... externally greenish brown, fre-
quently covered
green or reddish
pieces; fusible; odor balsamic; taste somewhat acrid.

Guaiac melts between 85° and 90° C. It is readily soluble in alcohol, chloroform, ether and in solutions of the alkalis.

... tains several resin acids: a mixture of α- and guaiacinic
... cent, guaiaretic acid, 10 per cent; and

STANDARDS AND TESTS.—Guaiac yields not more than 15 per cent of alcohol-insoluble residue and not more than 2 per cent of acid-insoluble ash.

When 1 drop of ferric chloride T S is added to 5 cc. of a 1 per cent alcoholic solution of guaiac, a deep blue color forms which gradually changes to green and finally becomes yellow. When a mixture of 5 cc. of an alcoholic solution of guaiac and 5 cc of water is shaken with 20 mg of lead peroxide, a deep blue color is developed If the solution is filtered and the filtrate boiled, the color

of α-guaiaconic acid It is formed
solution of guaiac is employed as a
Guaiac should be free from adulteration with rosin, which may be detected by means of the cupric acetate test.

USES AND DOSE.—Guaiac is a stimulant, a diaphoretic and an alterative. Average dose, 1 gm

oil and cresols or phenols. The exudate is produced by metamorphosis of the walls of the epidermis and trichomes The separated exudate is known as Sonora Gum An infusion of the leaves has been used in throat, bronchial and pulmonary complaints

RUTACEÆ, OR RUE FAMILY

Most of the members of this family, which numbers about 120 genera and 900 species, are trees and shrubs, with compound leaves, regular, 3- to 5-merous flowers and capsular fruits. With very few exceptions they possess schizogenous or schizolysigenous cavities in the branches and leaves, giving rise to transparent dots in the latter They usually have isolated groups of bast fibers in the pericycle, in *Pilocarpus*, however, there is a composite and continuous sclerenchymatous ring Calcium oxalate is usually secreted in the form of rosette aggregates, but styloids, raphides and membrane crystals are also present, the latter being especially prominent in the genus *Citrus* Both glandular and non-glandular hairs are present, stellate hairs being quite common in the family.

ORANGE

Sweet Orange Peel (U. S P. 1820 to date) is the fresh, outer rind of the non-artificially colored ripe fruit of *Citrus sinensis* Linné The inner, white portion of the rind should be excluded. *Citrus* is the ancient Latin name for the plant; *aurantium* refers to the golden yellow color of the fruit; *sinensis* indicates that the plant is cultivated in China The plant is a tree of medium height and appears to have originally come from China, although at present it is cultivated in many subtropical localities, our supply coming largely from California and Florida. The pulp of the **sweet orange** is eaten as a delicacy and the juice consumed as a beverage Both the pulp and juice are rich in vitamin C, and contain citric and other fruit acids and sugars. The sweet orange was not known to the ancient Greeks and Romans and was first brought

from China by the Portuguese in the fifteenth century. It was cultivated in Southern Europe and later in Florida and California.

Description.—The outer, orange yellow layer recently separated by grating or paring and consisting of epidermal cells, thick-walled parenchyma cells of the sarcocarp, with chromoplastids and occasionally calcium oxalate in monoclinic prisms 0.020 to 0 035 mm. in length, schizolysigenous oil cavities and globules of volatile oil; odor highly fragrant; taste pungently aromatic.

Constituents.—Volatile oil; bitter principles are practically absent.

Uses.—Sweet orange peel is an aromatic; it is used for flavoring other medicines.

Orange Oil or Oil of Sweet Orange (*U. S. P. 1882 to date*) is the volatile oil obtained by expression from the fresh peel of the ripe fruit of *Citrus sinensis* Linné. The usual methods for obtaining the oil are described under oil of lemon (page 375).

Description and Tests.—See the U. S. Pharmacopœia.

Constituents.—Oil of orange contains about 90 per cent of the terpene *d*-limonene, about 5 per cent of citral, citronellal and the methyl ester of anthranylic acid.

Standards.—Oil of orange which has a terebinthinate odor must not be used or dispensed. This odor is usually caused by the partial decomposition of the limonene which takes place upon exposure of the oil to air and light

Uses and Dose.—Oil of orange is principally used as a *flavoring agent*, although it is slightly carminative. Average dose, 0.1 cc.

Bitter Orange Peel (U. S. P. 1831 to date) is the dried rind of the unripe fruit of *Citrus Aurantium* Linné. The plant is a tree resembling the sweet orange tree, the latter being a va [illegible] Although a native of India it is widely cultivated [illegible] peel is removed from the unripe fruit by [illegible] The commercial article is obtained from Spain, Sicily, Tripoli and warm temperate South America. The bitter orange tree seems to have been introduced into Arabia, Africa and Syria by the Arabs, and subsequently reached Europe about 1200 A.D.

Description.—In quarters or irregular ribbons 2 to 6 mm. in thickness, outer surface weak brown to moderate olive with a green tinge, numerous small pits and fine reticulate ridges, inner surface, yellowish with many slight conical projections; fracture hard, short

Structure.—See Figure 101 [illegible] aromatic; [illegible] very small with close spiral markings or simple pores, [illegible] from 15 to 45 microns long

Constituents.—Volatile oil, resembling that of sweet orange peel but with a superior flavor and a bitter taste; several bitter principles: (*a*) aurantiamarin (1.5 to 2 5 per cent), an amorphous, bitter glucoside, to which the bitter taste is chiefly due, (*b*) aurantiamaric acid (0 1 per cent), a very bitter, green amorphous, resinous principle; (*c*) naringin (aurantin), a yellowish, crystalline, bitter glucoside; (*d*) isohesperidin (0.4 to 3 per cent), a slightly bitter glucoside; a fixed oil, a resin, a principle resembling tannin; and **Hesperidin**, a tasteless glucoside, 5 to 8 per cent It forms white sphere-crystals on placing the fresh fruit in alcohol. It is colored reddish brown with solutions of ferric chloride, and on hydrolysis yields 1 molecule of rhamnose, 2 of glucose and 1 of hesperetin, a sweet principle which crystallizes in prisms Total ash, about 4 3 per cent; acid-insoluble ash, 0.07 per cent.

USES.—Bitter orange peel is a tonic and a stomachic. It is also a carminative and stimulant

Orange Berries are the immature fruits of *Citrus Aurantium* Linné. They

same purposes as bitter orange peel.

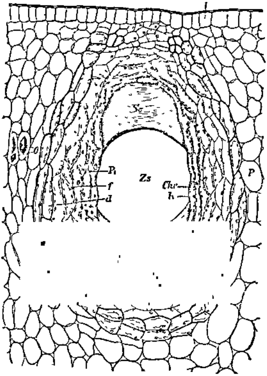


FIG 194 —*Citrus vulgaris* Longitudinal section of a young fresh fruit showing a lysigenous oil canal or duct *Se*, oil, *Zs*, cell sap, *Pi*, cells in which the walls have been dissolved, *f*, thinwalled cells, *d*, thick-walled cells, *h*, nucleus, *Chr*, chromoplasts, *o*, crystals of calcium oxalate, *E*, epidermis (After Meyer)

Bitter Orange Oil (N. F. 1916 to date) is a volatile oil obtained by expression from the fresh peel of the fruit of *Citrus Aurantium* Linné. The oil is obtained by one of the methods described under oil of lemon It is similar to oil of sweet orange, but is generally conceded to be superior to it in flavor. Consult the National Formulary for its characteristics.

USES AND DOSE.—Bitter orange oil is a flavor, a stimulant and a carminative. Average dose, 0.1 cc.

Orange Flowers (U S P 1863 to 1894) consists of the dried unexpanded flowers of *Citrus Aurantium* Linné (var *vulgaris* or *Bigarade* or *amara*) The bitter orange orchards of southern France, Italy, Sicily and Argentina are largely for the purpose of preparing oil of orange flowers by distillation. The fresh flowers yield from 0 6 to 1 per cent of the oil

The dried flowers are rather cylindrical, up to 25 mm in length and 8 mm. in diameter, yellowish or light tan in color, though before drying the fleshy petals are intensely white; odor fragrant, though less so than the fresh flowers

The dried flowers were used for the preparation of orange flower water before the French or Sicilian product was preserved and imported into this country.

Orange Flower Oil or Oil of Neroli (U. S. P. 1882 to 1905; N. F. 1916 to date) is the volatile oil distilled from the fresh flowers of *Citrus Aurantium* Linné. The aqueous distillate after removal of the oil constitutes **Orange Flower Water** (U. S. P. 1863 to date).

Consult the National Formulary for description, constants and tests

The oil consists of a complex mixture of the terpenes, *l*-pinene, *l*-camphene, dipentene, limonene, and about 47 per cent of terpene alcohols and their acetates, such as *l*-linalool, *d*-terpineol, geraniol, and nerol.

The oil and the orange flower water are used as pleasant flavorings in some pharmaceutical preparations; also to a considerable extent in the perfume and cosmetic industries.

LEMON

Lemon (U. S. P. 1820 to 1863) is the fruit of *Citrus Limon* (Linné) Burmann filius.

Lemon Peel (U. S. P. 1842 to date) is the outer yellow rind of the fresh ripe fruit of *Citrus Limon* (Linné) Burmann filius. *Limon* is from *limun*, the name of the fruit. The plant is a small evergreen tree with shining leaves, indigenous to northern India but cultivated to a considerable extent in subtropical regions, among which the following might be mentioned: southern Spain, southern Italy, Sicily, southern California, Florida, Jamaica and Australia. The history of the lemon parallels that of the orange; it has been known from the beginning of the written history of India, its native land. It was brought to the levant by the Arabs and either by them or by the Crusaders introduced into Europe during the twelfth century.

DESCRIPTION.—The outer, lemon-yellow or dark yellow layer is removed by grating or pari [illegible] ive odor and aromatic taste

STRUCTURE [illegible] small tabular cells, a hypodermal layer [illegible] oplastids, a mesocarp with colorless, thin-walled parenchyma and large, ellipsoidal schizolysigenous oil cavities, parenchyma cells contain a layer of granular protoplasm adhering to the walls and occasionally membrane crystals of calcium oxalate, which are irregularly polygonal in shape, polarize light strongly and are from 15 to 25 microns in diameter.

CONSTITUENTS.—Volatile oil, a very small quantity of hesperidin; bitter principles, a principle resembling tannin; calcium oxalate. Total ash, about 4 per cent, acid-insoluble ash, about 0.1 per cent.

USES.—Lemon peel is a flavoring agent, a stimulant and a stomachic It is employed chiefly in combination with other drugs.

Lemon Juice (U. S. P. 1863 to 1916) contains 5 to 8 per cent of citric acid, [illegible] 0 52 per cent; invert [illegible] s, 0 32 per [illegible] d calcium [illegible] phosphates.

Besides the above-mentioned constituents which make it valuable as a refrigerant drink, lemon juice is also high in vitamin C content.

Citric Acid (U. S P. 1820 to date) was first isolated from lemon juice by Scheele in crystal form in 1784. It is present in many fruits

and plants, and commercially is obtained from lemons, limes or pineapples, but mostly by fermentation of sucrose. It occurs in colorless, odorless, translucent crystals and is readily soluble in water and alcohol. It is used in refrigerant and diuretic beverages. Industrially it serves a wide variety of uses.

Lemon Oil (U. S. P. 1820 to date) is the volatile oil obtained by expression, without the aid of heat, from the fresh peel of the fruit of *Citrus Limon* Linné, with or without the previous separation of the pulp and the peel. There are six processes utilized in the recovery of oil of lemon, four of which yield an oil meeting the pharmacopœial requirements. (1) The outer portion of the rind which contains the volatile oil is removed by grating and the resulting raspings placed in canvas bags and subjected to pressure. The resulting turbid oil is allowed to stand until the sediment separates, after which the oil is decanted. (2) The sponge process is employed to a considerable extent in Sicily and along the Riviera. The lemon is peeled and pieces of the peel are pressed flat so as to flex them and rupture the oil cells. The oil is absorbed by the sponge which, when it becomes saturated, is squeezed out, and the process repeated. (3) The entire fruits are rotated in a saucer-shaped container having several rows of sharp metal pins and called an *écuellé a piquer*. The pins rupture the oil cells, the exuding oil collecting in a long narrow depression in the bottom of the saucer, which also serves as the handle. (4) In the machine process used in Italy the oil is separated mechanically, the principle of which simulates that of the *écuellé a piquer*. (5) Cold-pressed California oil is obtained by the application of extremely high pressure to the lemons and the very rapid removal of the juice and oil, which mixture is then separated by high-speed centrifugal separation at the lowest feasible temperature and in the shortest possible time. (6) Some oil of lemon is obtained by distillation. Such oil is not comparable with the expressed oil and does not conform to the pharmacopœial definition. Distilled oil is usually used for the preparation of terpeneless oil of lemon.

Description, Constants and Tests.—See the U. S. Pharmacopœia.

Constituents.—Oil of lemon contains about 90 per cent of terpenes consisting chiefly of *d*-limonene; about 4 per cent citral, which is the most important constituent, and small quantities of citronellal, geranyl acetate, terpineol, methyl heptenone, a sesquiterpene and octyl and nonyl aldehydes.

Standards.—Oil of lemon which has a terebinthinate odor must not be used or dispensed (decomposed terpenes or added oil of turpentine).

Uses and Dose.—Oil of lemon is a stimulant, carminative and stomachic. It is largely used as a flavor. Average dose, 0.1 cc.

Adulterants.—Oil of turpentine was formerly used as an adulterant, but this has been replaced by terpenes obtained in the preparation of terpeneless oils. The U. S. P. X required the oil to contain at least 4 per cent citral, yet even such a citral content is no criterion of purity since citral from a cheaper source (oil of lemon grass which contains about 80 per cent citral) may be added. Only a careful check of the physical and chemical constants of the oil will determine its purity.

Terpeneless Oils.—Oil of lemon and oil of orange by virtue of their high terpene content often develop a terebinthinate odor on keeping. A considerable amount of these terpenes may be removed by distillation under reduced pressure

A terpeneless oil of lemon with a citral content of 40 to 50 per cent may be prepared, and ir
been removed.
in smaller quan
considerably hi

PECTIN

Pectin (N. F. 1942 to date) is a purified carbohydrate product obtained from the dilute acid extract of the inner portion of the rind of citrus fruits or from apple pomace. It consists chiefly of partially methoxylated polygalacturonic acids. *Pectin* is from the Greek meaning congealed or curdled.

Pectin yields not less than 7 per cent of methoxyl groups and not less than 78 per cent of galacturonic acid. It differs from "commercial" pectin in that it contains no sugars or organic acids, but is pure pectin to which no additions have been made.

Pectin in fruit is in an insoluble form known as protopectin; it is converted to the soluble form by heating the fruit with dilute acid. This solution of pectin can be precipitated by means of alcohol or by "salting out;" then washed and dried.

Pectin occurs as a coarse or fine powder, yellowish white in color, almost odorless and with a mucilaginous taste. It is completely soluble in 20 parts of water, the solution being viscous, opalescent, colloidal, and acid to litmus paper; one part of pectin heated in nine parts of water forms a stiff gel For Tests of Identity and Purity

Pectin has a wide use as .. om-
mercially. Therapeutically, ing
of ulcers, acting to keep out bly
it stimulates the growth of new cells.

BERGAMOT OIL

Bergamot Oil (U. S. P. 1842 to 1905; N. F. 1916 to date) is a volatile oil obtained by expression from the rind of the fresh fruit of *Citrus Bergamia* Risso et Poiteau. The name *bergamia* is from the Turkish *beg-armudi*, meaning literally *prince's pear* and refers to the pear-shaped fruit. The plant is a small tree yielding non-edible fruits having a thick yellow rind from which the volatile oil is obtained by expression. The trees are cultivated in southern Europe, Asia and tropical America, Italy and France yielding most of the commercial supply.

CONSTITUENTS.—Oil of bergamot yields not less than 36 per cent of esters, calculated as linalyl acetate $C_{10}H_{17}C_2H_3O$.

USES.—Oil of bergamot is used as a perfume, being especially adapted for hair tonics and other external preparations.

Lime Juice (N. F. 1916 to 1926) is the juice expressed from the fresh fruit of *Citrus aurantifolia*. It contains from 5 to 10 per cent of citric acid and is used in refrigerant drinks.

Citron is the fruit of *Citrus Medica* Linné. The fruit is large and the thick rind is "candied" to form a popular confection.

Grapefruit is the ripe fruit of *Citrus paradisi*, and is widely used as a succulent and refrigerant food, rich in vitamin C.

Bael Fruit or Bengal Quince is the fruit of ... to India. The fruit somewhat resembles an mildly astringent, although it contains no tan and dysentery.

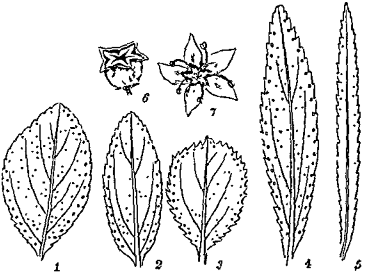


FIG. 195 —Buchu leaves, showing oil cavities which give the leaves a glandular-punctuate appearance 1, *Barosma crenata ovalis;* 2, *B. crenulata latifolia,* 3, *B. betulina,* 4, *B serratifolia,* 5, *Empleurum ensatum,* 6, dehiscent fruit of *B crenulata,* 7, flower of the same (After Tschirch)

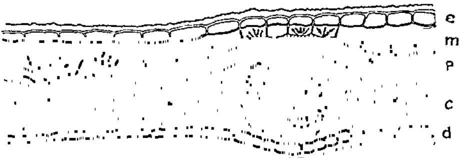


FIG 196 —Transverse section through the leaf of *Barosma serratifolia* Willd. *e,* epidermal cells of upper surface, the inner walls of which are mucilaginous and resting upon a single row of hypodermal cells mostly mucilaginized The mucilage (*m*) frequently includes dendritic excretions of diosmin in the form of feather-like aggregates, which dissolve in solutions of potassium hydroxide, giving a yellow color, *p,* palisade cells, some of which contain rosette aggregates of calcium oxalate, *c,* chlorenchyma, some of the cells containing rosette aggregates of calcium oxalate, also a large vascular bundle (mestome strand) with a steromatic pericycle forming an arch on the dorsal face, *d,* epidermis of lower (or dorsal) face of the leaf (After Solereder.)

BUCHU

Buchu (U. S. P 1842 to 1936; N. F. 1936 to date) is the dried leaf of *Barosma betulina* (Thunberg) Bartling et Wendland, known in commerce as Short Buchu (1842 to date); or of *Barosma crenulata* (Linné) Hooker, known in commerce as Oval Buchu (1842 to 1905, 1926 to date, though sometimes called Short Buchu); or of *Barosma serratifolia*

(Curtis) Willdenow, known in commerce as Long Buchu (1882 to 1894, 1916 to date).

Buchu is from the Zulu name for the drug, *bucu; Barosma* refers to the heavy odor of the leaves; *serratifolia* and *crenulata* refer to the character of the margins of the leaves; and *betulina* means birch-leaf-like.

The plants are low shrubs indigenous to Cape Colony, S. Africa, and the drug is collected from the wild plants. Buchu was in use by the Hottentots when white men first visited this territory, and was introduced into Europe about 1821 by the Cape Colony colonists.

Description and Structure.—See Figures 195 and 196 and the National Formulary.

Powder.—Greenish yellow; odor aromatic, mint-like; taste camphoraceous; calcium oxalate in rosettes, 15 to 30 microns in diameter; epidermal cells with irregular masses or sphere crystals of diosmin, 30 to 500 microns in diameter, and with walls modified to mucilage; few simple hairs; fragments of lower epidermal tissue with numerous stomata; fragments of chlorenchyma with numerous oil-secretion cavities and oil globules.

Constituents.—Short buchu contains from 1.2 to 1.45 per cent of a volatile oil, and long buchu contains about one-third as much; the oil contains about 30 per cent of *diosphenol* or buchu camphor ... and boiling at 232° C.; the terpines *d*-l ... *l*-menthone. Buchu also contains the ... peridin. (Diosmin has been reported as hesperidin in many plants.) It yields glucose, rhamnose and diosmetine on hydrolysis.

Standards.—Buchu contains not more than 8 per cent of the stems of the plants yielding buchu and not more than 2 per cent of other foreign organic matter, and yields not more than 1 per cent of acid-insoluble ash.

Uses and Dose.—Buchu is a diuretic and a carminative. The volatile oil is excreted by the kidneys, rendering the urine slightly antiseptic. Average dose, 2 gm.

Adulterants and Substitutes.—The leaves of *Empleurum ensatum* (see Fig. 195) have been offered ... about 1 ... d
The leav ...
small ...

... and have numerous simple hairs.

Karoo Buchu is derived from *Diosma succulenta*, of South Africa. The leaves are ovate, 3 to 6 mm. in length ... the apex. They yield an ... and 26 per cent of ex... smaller than those of ...

Rue (U. S. P. 1831 to ... The plant is a low shrub with flesh... cymes. It has a strong... The leaves bear many ... oil. The fresh leaves m... contains rutin, a glycosidic coloring principle, also present in lemon peel, buckwheat leaves, black currant fruit, and other plants; it may contain or be related to vitamin "P," which is supposed to have an important effect on resolving arteriosclerosis and restoring the capillary function of assimilation.

Oil of Rue (U. S. P. 1873 to 1894) is obtained by steam distillation of the fresh leaves of *Ruta graveolens* L. It is of a yellowish or greenish color, darkens and thickens upon aging, and possesses the odor and taste of the leaves. It solidifies at about 10° C. It consists chiefly of methyl-nonylketone.

poisonous.

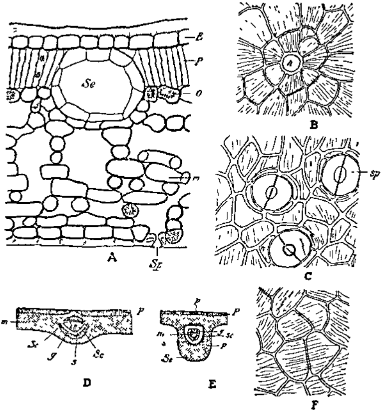


Fig 197 —*Pilocarpus pinnatifolius* *A* Transverse section of lamina showing upper epidermis (*E*), oil cavities (*Se*) palisade cells (*P*), some of which contain rosette aggregates of calcium oxalate, loose parenchyma (*m*), some of the cells of which conta...

lamina (After Meyer)

Pilocarpus or Jaborandi (U S P. 1882 to 1916) consists of the leaflets of

base rounded or acute, unequal; margin entire, slightly revolute; upper surface dark green or brownish green, glabrous, under surface yellowish or greenish brown, pubescent, with numerous light brown projections, midrib prominent;

(Curtis) Willdenow, known in commerce as Long Buchu (1882 to 1894, 1916 to date).

Buchu is from the Zulu name for the drug, *bucu; Barosma* refers to the heavy odor of the leaves; *serratifolia* and *crenulata* refer to the character of the margins of the leaves; and *betulina* means birch-leaf-like.

The plants are low shrubs indigenous to Cape Colony, S. Africa, and the drug is collected from the wild plants. Buchu was in use by the Hottentots when white men first visited this territory, and was introduced into Europe about 1821 by the Cape Colony colonists.

DESCRIPTION AND STRUCTURE.—See Figures 195 and 196 and the National Formulary.

POWDER.—Greenish yellow; odor a
calcium oxalate in rosettes, 15 to 30 r
irregular masses or sphere crystals of
and with walls modified to mucilage; few simple hairs; fragments of lower epidermal tissue with numerous stomata; fragments of chlorenchyma with numerous oil-secretion cavities and oil globules.

CONSTITUENTS.—Short buchu contains from 1.2 to 1.45 per cent of a volatile
oil, and long buchu cor
30 per cent of diosphen
and boiling at 232° C.;
l-menthone. Buchu als
peridin. (Diosmin has
glucose, rhamnose and diosmetine on hydrolysis.

STANDARDS.—Buchu contains not more than 8 per cent of the stems of the *plants yielding buchu and not more than 2 per cent* of other foreign organic
matter, and yields not more than he volatile oil

USES AND DOSE.—Buchu is a itic. Average
is excreted by the kidneys, rend..
dose, 2 gm.

ADULTERANTS AND SUBSTITUTES.—The leaves of *Empleurum ensatum* (see Fig. 195) have been offered for long buchu. They have a bitter taste and yield about 1 per cent of a volatile oil which does not contain a crystalline principle.

and glandular and have numerous simple hairs.

Karoo Buchu is derived from *Diosma succulenta*, of South Africa. The leaves
are ovate, 3 to 6 mm. in length, recurved at the
apex. They yield an oil with ning diosphenol,
and 26 per cent of extractive *B. pulchella*) are
smaller than those of *B. betulina* and have an odor of citronella.

Rue (U. S. P. 1831 to 1882) is the leaves of *Ruta graveolens* Linné. The plant is a low shrub with fleshy leaves, 2- to 4-pinnatifid, and yellow flowers in terminal cymes. It has a strong, disagreeable odor, and a bitter, acrid, pungent taste. The leaves bear many short-stalked glands containing a very irritant volatile oil The fresh leaves may blister the skin if applied or handled. The drug also
in lemon peel, buck-
in or be related
t on resolving
arteriosclerosis and restoring the capillary function of assimilation.

Oil of Rue (U. S. P. 1873 to 1894) is obtained by steam distillation of the fresh leaves of *Ruta graveolens* L. It is of a yellowish or greenish color, darkens and thickens upon aging, and possesses the odor and taste of the leaves It solidifies at about 10° C. It consists chiefly of methyl-nonylketone.

poisonous.

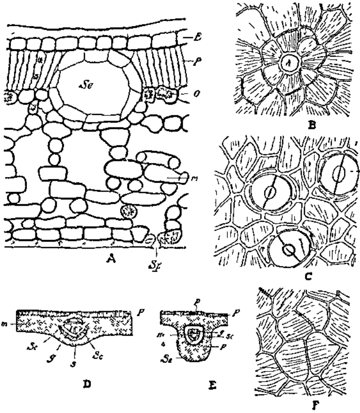


FIG. 197 —*Pilocarpus pinnatifolius* A, Transverse section of lamina showing upper epidermis (*E*), oil cavities (*Se*), palisade cells (*P*), some of which contain rosette aggregates of calcium oxalate, loose parenchyma (*m*), some of the cells of which contain calcium

lamina (After Meyer)

Pilocarpus or Jaborandi (U. S. P 1882 to 1916) consists of the leaflets of *Pilocarpus Jaborandi* Holmes (Pernambuco Jaborandi, 1894 to 1916); of *Pilo-*

base rounded or acute, unequal; margin entire, slightly revolute; upper surface dark green or brownish green, glabrous; under surface yellowish or greenish brown, pubescent, with numerous light brown projections, midrib prominent,

glandular-punctate; texture coriaceous, brittle; odor slight; taste bitter, somewhat aromatic, becoming pungent.

Paraguay jaborandi is somewhat broader, sometimes obovate, thinner and less coriaceous and frequently with black disk-like fruits of a species of *Puccinia* on both surfaces.

Maranham jaborandi is smaller, coriaceous but rather thin, and frequently bearing the same *Puccinia* fruiting heads as found on Paraguay jaborandi.

The structure anc ... ıd 198.

All of the commer ... 1 per cent of the alkaloid pilocarpine.

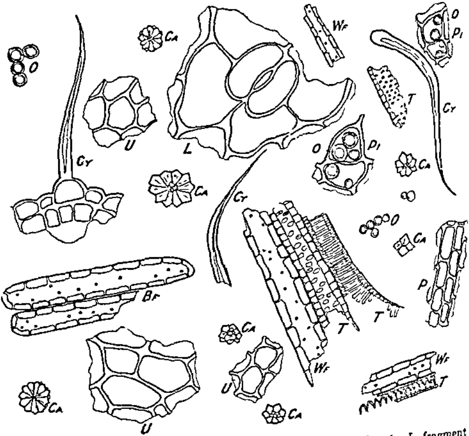


FIG. 198.—Powder of Pilocarpus. *U*, Fragments of upper epidermis, *L*, fragment of lower epidermis with a stoma, *Cy*, non- ... 10 to 27 microns in diameter, *Bf*, bast fibers, *Wf*, ... hick- enings and simple and bordered pores, ... s, *O*, oil globules, *P*, parenchyma cells. (Drawing by Haase)

Pilocarpine Nitrate (U. S. P. 1905 to date) and **Pilocarpine Hydrochloride** (U. S. P. 1882 to 1936; N. F. 1936 to date) are salts of an alkaloid obtained from the dried leaflets of *Pilocarpus Jaborandi* Holmes, or of *Pilocarpus microphyllus* Stapf.

Pilocarpine is the lactone of pilocarpic acid, an acid having a glyoxaline nucleus. It is an oily, syrupy liquid, though its salts crystallize easily. It is usually obtained by treating the powdered leaves with sodium carbonate, extracting with benzene and then shaking the benzene extract with dilute hydrochloric or nitric acid. The aqueous solution is then made alkaline and shaken ... loroformic solution then shaken with acid and ... crystallize.

[illegible]

hydrogen peroxide and potassium dichromate is, however, characteristic.

USES AND DOSE.—The salts of pilocarpine are preferred to galenicals made [illegible] horetic, a sialagogue and a myotic Average [illegible]

[illegible] (U. S. P 1820 to 1926; N. F. 1926 to 1947) is the dried bark of *Zanthoxylum americanum* Miller, known in commerce as Northern Prickly Ash Bark (1820 to 1947); or of *Zanthoxylum clava-herculis* Linné, known in commerce as Southern Prickly Ash Bark (1873 to 1947). *Zanthoxylum* is from two Greek [illegible] the [illegible] nt of [illegible] is a [illegible] outh Dakota, Nebraska and Kansas, *Z. clava-herculis* is a shrub or tree found south from Virginia to Texas.

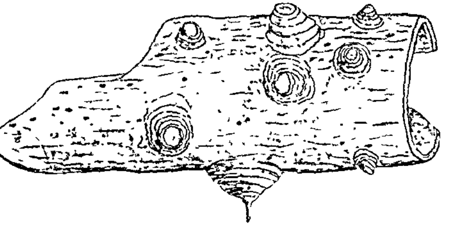


FIG. 199—Southern Prickly Ash A piece of the bark from commercial drug showing corky warts occasionally surmounted by a thorn (Drawing by E H Wirth)

The use of [illegible] tion of the In[illegible] settlers for th[illegible] drug also enj[illegible]

Prickly ash bark is in transversely curved or flattened pieces or in single q[illegible] to 4 mm. in thick- n[illegible]y, or where cork is a[illegible] may show lighter- c[illegible] flattened prickles. southern prickly ash bark shows large, conical projections of brownish cork up to 3.5 cm in diameter, or scars where these have been knocked off. The inner surface is yellowish to light brown, finely striate longitudinally, and with minute flashing crystals (Northern) when viewed with a lens under a bright light, but mostly devoid of these crystals in Southern.

The powder is light yellowish brown; odor slight, taste bitter, acrid and pungent; starch grains numerous, nearly spheroidal, from 2 to 10 microns in diameter; calcium oxalate chiefly in monoclinic prisms from 10 to 45 microns in length, occurring in crystal fibers and in parenchyma cells of the primary cortex; oil-secretion cavities having a nearly colorless or light yellowish oil;

cork cells strongly thickened and lignified; bast fibers, thick-walled, slightly lignified, swelling perceptibly in hydrated chloral T.S.

In Southern prickly ash occur groups of large, more or less lignified stone cells, up to 150 microns in diameter and the lignified cork cells are more numerous.

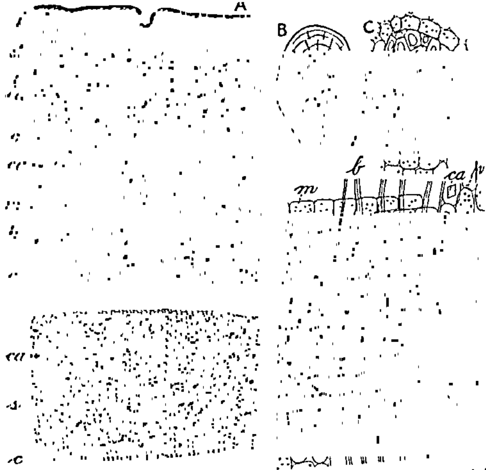


FIG 200.—Southern Prickly Ash. *A*, Transverse section showing lignified cork (*l*) frequently in successive strata especially in the projections, the strata being separated by [illegible] on the tangential wall; a layer of collen- [illegible] (*ca*)

sieve tissue (*s*), medullary rays (*m*) 1 to 3 cells wide, and cambium [illegible] the collenchyma is more prickly ash the lignified cork seldom exceeds 20 rows of cells, the collenchyma is more developed with thickened walls, and the stone cells are few. Scrapings from either the inner or outer surface show numerous rod-shaped crystals and flat prisms, up to 250 microns in length, which polarize light with a display of bright colors. *B*, Isolated stone cells showing pores and lamellæ. *C*, Group of bast fibers found in young, thin bark and surrounded by parenchyma (*p*) *D*. Longitudinal section near a group of bast fibers showing non-lignified bast fibers (*b*), calcium oxalate (*ca*) in crystal fibers, medullary ray (*m*), parenchyma (*p*) containing starch

The drug contains two resins, one acrid, the other crystalline and bitter; an acrid volatile oil, a bitter alkaloidal principle, somewhat resembling berberine; a crystalline phenol compound, xanthoxylin; total ash, about 6 per cent, acid-insoluble ash, 0.3 per cent.

Xanthox[illegible] alterative. Average dose, 2 gm.

The bar[illegible] ure 201, is a common sub-
stitute of [illegible] ckly ash bark from which

the corky cones have been removed by scraping has been substituted for northern prickly ash bark

Xanthoxylum Fruit or Prickly Ash Berries (N F 1916 to 1947) is the dried full-grown fruit of *Zanthoxylum americanum* Miller, known in commerce as Northern Prickly Ash Berries, or of *Zanthoxylum clava-herculis* Linné known in … e fruits are collected when full

… in length, fleshy, gray-brown

pericarp of narrow, irregular, elongated cells with thick lignified walls, polygonal cells of the seed coat with dark brownish walls, numerous globules of volatile oil

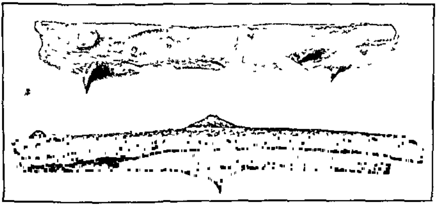


FIG 201 —Northern Prickly Ash bark below, showing the longitudinally elongated spines, bark of *Aralia spinosa* above, with nearly circular spines

Prickly ash berries contain a resin and a volatile oil, of which citral is one of the constituents Total ash, 5 55 per cent, acid-insoluble ash, 0.13 per cent

The drug is a tonic, a mild stimulant, a diaphoretic and an alterative Average dose, 1 gm.

Angostura Bark, or Cusparia Bark (U. S P 1820 to 1882) is the bark of *Galipea officinalis*, a small tree growing abundantly in the mountainous districts of Venezuela It was formerly used in the preparation of Angostura Bitters, which also contained gentian and a number of aromatic substances, as ginger, cinnamon, cardamom, orange or lemon peel, and caraway or cloves

…ly curved pieces, from 5 to 12 cm in … to 3 mm. in thickness, externally ligl… sional patches of a velvety porous cork; inner surface light brown and finely striate, fracture short, smooth and resinous; transverse surface of middle bark brownish red, inner bark brownish yellow with numerous shining resin canals and groups of bast fibers, odor distinct; taste bitter. Five alkaloids (cusparine, galipine, cusparidine, galipidine and cuspareine) have been isolated Angostura is an aromatic bitter, it is a stimulant, a tonic and a stomachic It is interesting to note that the bark of *Strychnos nux vomica* has been substituted for angostura and has produced

…

tributed throughout Mexico and Central America. The fruit and seed of this

tree are recognized by the Pharmacopœia of Mexico under the title of **Zapote Blanco.** The fruit is edible, although said to induce sleep, whereas the kernels of the seed have been regarded as deleterious or even fatal in their effects.

SIMARUBACEÆ, OR QUASSIA FAMILY

This family, which comprises about 30 genera and 150 species, consists chiefly of tropical or subtropical trees and shrubs, with alternate and pinnately compound leaves, regular flowers and drupaceous or samara-like fruits. Resin canals occur only in the peripheral region of the pith and are seldom found in the cortex. The hairs are usually both unicellular non-glandular and multicellular glandular. Calcium oxalate is usually secreted in the form of rosette aggregates or solitary crystals; in some instances styloids occur. *Ailanthus glandulosa*, Tree of Heaven, is a commonly cultivated member of the family.

FIG. 202.—Jamaica Quassia. *a*, Wood fibers; *b*, tracheal tubes; *c*, medullary rays; *d*, wood parenchyma with prismatic crystals. The drawings (from *A*, transverse, *B*, tangential, and *C*, radial sections) are diagrammatically combined into a cube. (Drawing by Helen Day.)

QUASSIA

Quassia *or* **Bitter Wood** (U. S. P. 1820 to 1936; N. F. 1936 *to date*) is the wood of *Picrasma excelsa* (Swartz) Planchon, known in commerce as Jamaica Quassia, or of *Quassia amara* Linné, known in commerce as Surinam Quassia. *Quassia* is from *Quassi*, the name of a Surinam negro who first discovered the febrifuge properties of the drug; *picrasma* is

Greek meaning bitter; *amara* is Latin for bitter, and *excelsa* is from the Latin meaning surpassing, *i. e.*, the tallest tree in the genus. *Picrasma excelsa* is a tree attaining a height of about 25 meters, growing in the West Indies, while *Quassia amara* is a branching shrub or small tree attaining a height of 2 to 3 meters and found in Venezuela, northern Brazil and the Guianas The wood is usually cut into logs (see Fig. 7)

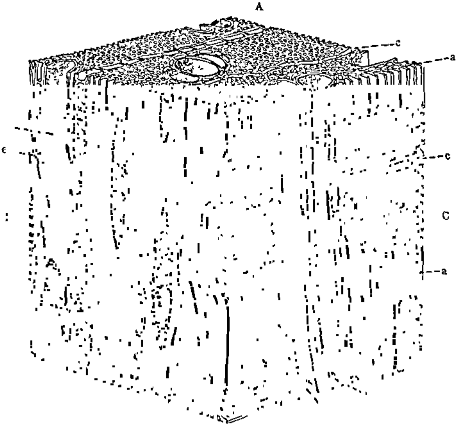


FIG 203 —Surinam Quassia *a*, Wood fibers, *b*, tracheal tubes, *c*, medullary rays. The drawings (from *A*, transverse, *B*, tangential, and *C*, radial sections) are diagrammatically combined into a cube (*Drawing by E H Wirth*)

for shipment. "Quassia Cups" were formerly turned from the wood and the shavings used as the drug The drug consists of chips, raspings or shavings. Quassia seems to have been used in Surinam as early as 1714 for the treatment of malignant fevers. The drug was at one time almost exclusively obtained from *Quassia amara* but now is largely derived from *Picrasma excelsa*.

DESCRIPTION AND STRUCTURE —See Figures 202, 203, 204 and the National Formulary.

POWDER —Light yellow, tracheal fragments with bordered pores, wood fibers

a few stone cells and cork [illegible] of Surinam quassia [illegible]

[illegible] a bitter crystalline [illegible] of two crystalline principles, α-picrasmin [illegible] picrasmin; an alkaloidal principle which gives a blue fluorescence in acidified alcoholic solution. Total ash, about 3.75 per cent; acid-insoluble ash, about 0.1 per cent.

USES AND DOSE.—Quassia is a bitter tonic. It is also used, in the form of an enema, as an anthelmintic. Average dose 0.5 gm.

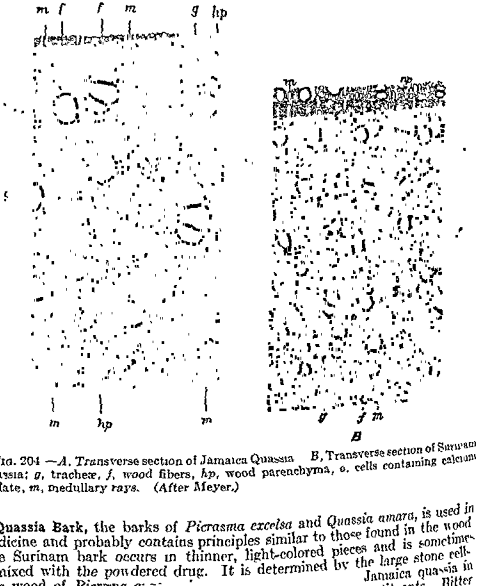


FIG. 204.—*A*, Transverse section of Jamaica Quassia. *B*, Transverse section of Surinam Quassia; *g*, tracheæ, *f*, wood fibers, *hp*, wood parenchyma, *c*, cells containing calcium oxalate, *m*, medullary rays. (After Meyer.)

Quassia Bark, the barks of *Picrasma excelsa* and *Quassia amara*, is used in medicine and probably contains principles similar to those found in the wood. The Surinam bark occurs in thinner, light-colored pieces and is sometimes admixed with the powdered drug. It is determined by the large stone cells [illegible] Jamaica quassia in [illegible]

The wood of *Pi*[illegible] [illegible] constituents. Bitter general [illegible] assia.

[illegible] principl[illegible] [illegible] e root of *Simaruba*

Simar[illegible] [illegible] Brazil, [illegible]

[illegible] tr[illegible]

[illegible] *…ruba*, the latter [illegible] Islands and Florida, and yielding [illegible] root bark is collected and deprive[illegible] supplies come from Ciudad Bolivar [illegible]

Orinoco simaruba occurs in flattened or transversely curved pieces, from 4 to 12 cm. in width, and from 2 to 5 mm. in thickness; externally grayish or yellowish brown, somewhat velvety to the touch, irregularly wrinkled, with occasional patches of the shining silvery periderm; inner surface yellowish brown, longitudinally striate; fracture short fibrous, porous and with yellowish stone

acid, and calcium oxalate and malate

Simaruba is a bitter tonic.

BURSERACEÆ, OR MYRRH FAMILY

This family, comprising 13 genera and about 140 species, consists largely of tropical shrubs and trees, having alternate compound leaves and small flowers formed in racemes. The plants are especially distinguished by their internal secretory system. Schizo-lysigenous balsam canals or gum-resinous canals (Fig. 205) occur within the sclerenchymatous pericycle, also in the secondary cortex and medullary rays and occasionally in the primary cortex and pith. The epidermal layer in the leaves is usually modified to mucilage. The pericycle is a composite and continuous ring of sclerenchyma. The tracheæ as a rule have simple perforations, which are very large in the walls adjoining the parenchyma cells. The medullary rays are narrow. Calcium oxalate is secreted in the form of rosette aggregates or solitary crystals (Fig 205). Glandular and non-glandular hairs are of a number of specific forms.

MYRRH

Myrrh or Gum Myrrh (U. S. P. 1820 to date) is an oleo-gum-resin obtained from *Commiphora abyssinica* (Berg) Engler or from *Commiphora molmol* Engler or from other species of *Commiphora*. The name Myrrh is from the Arabic *murr*, meaning bitter; *Commiphora* is from the Greek, meaning gum bearing; *molmol* is the native Somali name, and *abyssinica* refers to the habitat of the plants. The plants are small trees sometimes attaining the height of 10 meters and found growing in Arabia, Abyssinia, and Somaliland.

The gum-resin exudes naturally or from incisions made in the bark, it is first of a yellowish color, but soon hardens, in the intense heat of these countries, becoming darker, and is then collected. There are two principal commercial varieties of myrrh, the one known as **African or Somali Myrrh**, and the other as **Arabian or Yemen Myrrh**, the former being considered the better of the two.

There are numerous references to myrrh in the Old Testament, but it is highly possible that the product thus designated was one of the bdelliums. Myrrh was an ingredient of the embalming material of the Egyptians. Its use in incense and perfumes in ceremonial religious life since the days of remote antiquity is well known. Theophrastus, Pliny and other early writers mention it and from early times it has been valued in domestic medicine for its aromatic qualities.

DESCRIPTION.—In irregular, agglutinated tears or masses; externally rough and uneven, yellowish to reddish brown, covered with a yellowish dust; brittle, the fractured surface waxy, granular, oily, mottled, somewhat translucent in thin pieces; odor balsamic; taste aromatic, bitter and acrid.

POWDER.—In glycerin mounts the powder shows yellow or yellowish brown irregular fragments made up of a grayish matrix, containing oil globules, a few fragments of lignified tissues consisting of either sclerenchymatous fibers, or of small groups of stone cells, the individual cells of the latter having very thick, porous walls and being from 15 to 50 microns in length; and occasional starch grains from 10 to 35 microns in diameter and varying from spheroidal to somewhat pear-shaped grains.

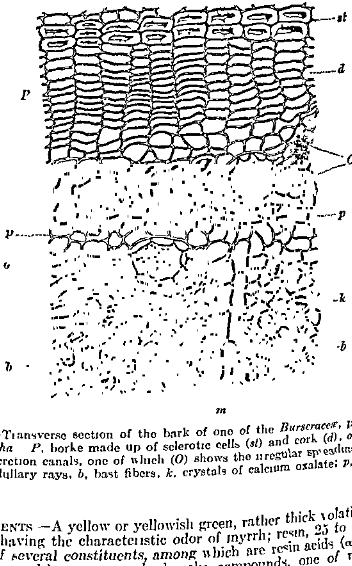


FIG. 205.—Transverse section of the bark of one of the *Burseraceæ*, probably *Commiphora myrrha*. *P*, borke made up of sclerotic cells (*st*) and cork (*d*). *o*, more or less spheroidal secretion canals, one of which (*O*) shows the irregular spreading of the gum-resin, *m*, medullary rays, *b*, bast fibers, *k*, crystals of calcium oxalate; *p*, parenchyma. (After Vogl.)

CONSTITUENTS.—A yellow or yellowish green, rather thick volatile oil, 2.5 to 8 per cent, having the characteristic odor of myrrh; resin, 25 to 40 per cent, composed of several constituents, among which are resin acids (α-, β- and γ-commiphoric acids), resenes and phenolic compounds, one of which yields protocatechuic acid and pyrocatechin; gum, about 60 per cent, consisting of soluble and insoluble portions and forming a mucilage that does not readily ... ...binose as one of the products ... er but soluble in alcohol; ... ut 1 per cent, eugenol, meta-cresol, pinene, limonene, dipentene and two sesquiterpenes. The acidity of old oil is due to free acetic, myrrholic and commiphorinic acids.

Standards and Tests.—Myrrh yields not less than 30 per cent of alcohol-soluble extractive and not more than 5 per cent of acid-insoluble ash.

Myrrh forms a brownish yellow emulsion when triturated with water (distinction from other gum-resins), an ethereal solution treated with bromine

ien moistened

or bdellium).

frequently in

other gum-resins, including several

various species of *Commiphora*, and which are characterized by not giving a purplish color with nitric acid **African Bdellium** occurs in yellowish brown masses, reddish in transmitted light and with a pepper-like odor and bitter taste, **Indian Bdellium** occurs in irregular,

Bisabol, or East Indian Myrrh, is exported from eastern Africa and Asia; it resembles true myrrh, but an ethereal solution of it does not become reddish with bromine vapor A solution of Bisabol, 1 15 in petroleum ether, gives a red zone when 6 drops of it are admixed with 3 cc of glacial acetic acid and laid over 3 cc of sulfuric acid, later the entire acetic acid layer assumes the same color. With genuine myrrh a very pale rose color forms.

Opopanax

indigenous

It yields fr

balsamic o

Olibanum or Frankincense is the oleoresin obtained from *Boswellia carterii* and **Manila Elemi** is obtained from *Canarium commune*

MELIACEÆ, OR MAHOGANY FAMILY

This is a family numbering 37 genera and about 600 species of tropical and subtropical trees and shrubs, having mostly alternate and compound leaves and axillary clusters or racemes of flowers. The family is especially known for its yielding the mahogany wood, which is considered *one of the most durable and valuable of cabinet woods.* ***The true mahogany*** is obtained from *Swietenia mahagoni*, a native of tropical America and formerly very abundant in Jamaica; now, probably all of the mahogany wood comes from Central America It is cultivated in Florida and California as an ornamental tree Other genera of this family yield a wood which is substituted and sold for mahogany. Quite a number of timbers, obtained from plants entirely unrelated to the *Meliaceæ*, are also sold in commerce as mahogany.

Cocillana or Guapi Bark (N F. 1916 to 1926) is the bark of *Guarea Rusbyi* (Britton) Rusby. Guarea is the native name, and the species is named after Dr. H H. Rusby, who introduced the drug to medicine The natives use it as an emetic, as an expectorant it resembles ipecac in its action on the respiratory organs

The bark occurs in flattened or transversely curved pieces up to 2 cm. in thickness; externally grayish brown with whitish patches of a lichen, roughly and unevenly fissured, having longitudinal furrows and occasionally transverse fissures; inner surface brown, coarsely striate and often roughly fibrous from detached strands of bast fibers; fracture coarsely granular in the outer bark, and splintery fibrous in the inner bark; transverse surface with thick, light reddish brown periderm, having numerous slightly yellow stone cells, inner bark tangentially finely striate; odor slight; taste somewhat astringent, unpleasant and slightly nauseous.

Cocillana contains an alkaloid, *rusbyine*; a mixture of resins, 2.5 per cent; a fixed oil, 2.5 per cent; a caoutchouc-like substance; and tannic acid. Total ash about 7.5 per cent, acid-insoluble ash about 1.25 per cent. Cocillana is an expectorant ... age dose, 1 gm.

Azedaraci ... of the root of *Melia azedarach*, *a beautiful* ... *cultivated in Europe* and the southern U... is very astringent when green, yellow and ... on drying. It is poisonous to ... deprived of the periderm, ...e yellow ... patches, ...etached ...d somewhat acrid.

The drug contains a resin with anthelmintic properties, which is insoluble in water but soluble in alcohol, ether, chloroform, carbon disulfide, petroleum benzine and oil of turpentine. It is precipitated from alcoholic solutions by the addition of water.

Azedarach is used mainly as an anthelmintic.

Indian Azadirach, Margosa or Neen Bark, is the dried bark of *Azadirachta indica*, a tree indigenous to the East Indies and rather widely distributed in the tropical countries of Asia and to some extent cultivated. The botanical name means "a noble tree of India." **Assam or Bangalore Gum** is obtained from this tree.

The bark contains a bitter alkaloid, margosine; a bitter amorphous resin; margosic acid; and tannic acid. Azadirach is used in India and the eastern colonies of Great Britain as a simple bitter, *replacing gentian and quassia*

POLYGALACEÆ, OR MILKWORT FAMILY

This family consists of about 700 species, mostly herbs, except in the tropics where they may become shrubs and trees. The leaves are usually alternate and exstipulate, the flowers are perfect and *irregular* and the fruit is usually a capsule enclosing caruncled seeds. Among the histological features of this family the following may be mentioned. Only the transverse walls of the tracheæ are marked by simple pores. The wood fibers possess bordered pores, and the medullary rays are very narrow. The cells of the pith are sometimes lignified. In the leaves there are several important characteristics: (1) sclerotic cells are occasionally found in the loose mesophyll and palisade layer; (2) in *Polygala* there is a strong tendency for the epidermal cells to become papillose, thus resembling the leaves of *Erythroxylon;* and (3) terminal tracheids occur in the veins of *Polygala*. Non-glandular hairs are mostly unicellular, occasionally uniseriate. Glandular hairs are wanting.

SENEGA

Senega or Seneca Snakeroot (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried root of *Polygala senega* Linné. *Polygala* is from the Greek meaning "much milk" in reference to the early use of the plant

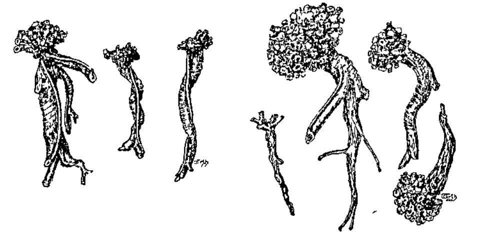


FIG. 206 —Senega nearly entire, with broken and detached rootlets, crowned with numerous buds and short stem remnants, slenderly conical, more or less tortuous, somewhat branched 3 to 15 cm in length, 2 to 10 mm in thickness, externally dark yellow, the crown being rose-tinted, longitudinally wrinkled, slightly annulate, marked with circular scars of detached rootlets and in some cases by a keel, which is more prominent at the upper portion of the dried roots; side opposite keel more or less flattened, fracture short when dry, tough when damp, odor slight, penetrating; taste sweetish and acrid (Drawings by Wirth)

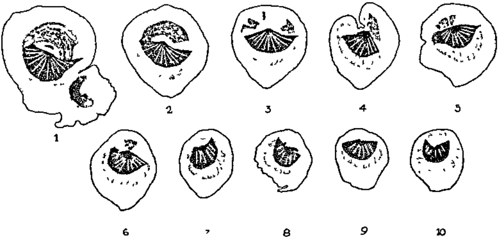


FIG 207 —Senega transverse sections cut through a root at equal intervals from tip

yellow cortex which is thickest outside the broadest strands of wood, and forms the keel on drying (Drawings by Carpenter; courtesy of the Journal of the Amer. Pharmaceutical Assn)

as a galactagogue; *senega* refers to the Seneca tribe of North American Indians. The plant is an herbaceous perennial with a large knotty crown from which several leafy stems up to 30 cm. high arise in the spring and die down in the fall. The roots are dug in the fall and carefully dried. There are two commercial varieties, the Northern, collected in Manitoba and Minnesota; the Southern, from Virginia to Texas.

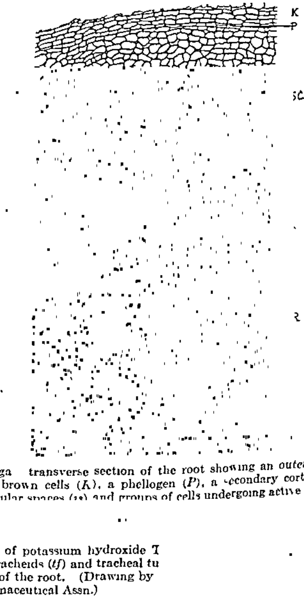


FIG. 208.—Senega transverse section of the root showing an *outer layer* of several rows of yellowish brown cells (*K*), a phellogen (*P*), a secondary cortex (*SC*) showing occasional intercellular spaces (*is*) and groups of cells undergoing active cell division (*cd*); ...enchyma ...a of

upon the addition of potassium hydroxide T
(*SV*) shows fiber tracheids (*tf*) and tracheal tu
seen at the center of the root. (Drawing by
of the Amer Pharmaceutical Assn.)

Senega was used by the Indians as a remedy for snake bite, was investigated by early American physicians, was known in Europe in 1738, and as one of the new American drugs, enjoyed a very early reputation as an expectorant and cough remedy.

DESCRIPTION AND STRUCTURE.—See Figures 206, 207 and 208.

POWDER.—Pale brown to weak yellow, odor suggesting methyl salicylate; somewhat sternutatory; taste sweetish, becoming strongly acrid; fragments may

show thin walled parenchyma, cork-like cells, sieve tissue, narrow tracheæ, short pointed tracheids with numerous simple or bordered pores, lignified medullary ray cells with simple pores

CONSTITUENTS.—About 5 or 6 per cent of two glucosides: senegin, which resembles saponin, and polygalic acid, which is sternutatory; 0.12 per cent of a volatile oil which is chiefly methyl salicylate, resin; pectin; sugar; and considerable proteins. Total ash, from 2.4 to 4 per cent, acid-insoluble ash, from 0.35 to 1.65 per cent.

USES AND DOSE.—Senega is an expectorant, a stimulant and an irritant. Average dose, 1 gm.

Polygala Rubella or Bitter Polygala (U. S. P. 1820 to 1882) is the dried root and herb of *Polygala rubella*. It is a biennial herb about 20 cm. high, growing in dry fields from Canada to the Gulf of Mexico. The leaves are alternate,

narrow raceme of purple, pendu-

taste. It contains a very bitter

Saponin

of *Polyga*

yielding

Polygalac

mmonly

senega,

but are from 7 to 20 cm. in length and from 1 to 9 mm in diameter. They are nearly cylindrical, more or less tortuous, light brown in color, longitudinally wrinkled and marked by numerous transverse fissures. The crown is surmounted with a number of stem-bases which somewhat resemble the roots. They probably contain saponin, and on this their emetic properties depend.

EUPHORBIACEÆ, OR SPURGE FAMILY

This is a large family of about 4000 species, which are widely distributed. Outside of the fact that the flowers are subtended by an involucre, which resembles a calyx, and the fruit is a 3-lobed capsule, there are no distinctive morphological features which extend throughout all members of this family. It is ordinarily stated that the plants possess a milky acrid juice, but this is only true of some of the genera. There are many different kinds of secretory tissues in this family. (1) **Lacticiferous tubular cells** are especially characteristic of Euphorbia. They occur in the pith, cortex, and in the veins of the leaves, and the milky contents may contain starch grains, protein crystals, rosette aggregates of calcium oxalate and tannin. (2) **Lacticiferous vessels** occur in *Hevea*, one or more species of which yield caoutchouc, and in *Manihot*, the tuberous roots of which furnish tapioca starch. In the former the juice is of a milky character and in the latter in the nature of a watery sap. (3) Rows of **laticiferous sacs** are confined to the genus *Micrandra*.

tory organ, consisting of very much elongated **sacs** having a brownish content, is found solely in the pith cells of *Mallotus* and some other genera. It is usually surrounded by a ring of small cells resembling an epithelium. (6) **Idioblasts**, or secretory cells with an oleoresin content,

are found in *Ricinus, Croton,* etc. The cells are large and contain a yellowish and strongly refractive secretion, giving rise to transparent dots in the leaves. (7) **Secretory lacunæ,** resembling the intercellular secretory receptacles, occur in some of the *Euphorbiaceæ.* (8) **Mucilage Lacunæ,** or groups of cells having mucilaginous walls, are found in a limited number of genera. Both glandular and non-glandular hairs occur in a number of specific forms. Stinging hairs are also found in a number of tropical genera.

FIXED OILS, FATS AND WAXES

Fixed oils, fats and waxes are mixtures of esters of aliphatic acids. In fixed oils and fats the alcohol is glycerol while in waxes a large number of higher straight-chain alcohols have been found.

Fixed Oils and Fats differ only as to melting point; those that are liquid at normal temperatures are known as *fatty* or *fixed oils* while those that are semisolid or solid at ordinary temperatures are known as *fats.* Also, there is no chemical difference between fats and oils of plant or of animal origin. While most vegetable oils are liquid at ordinary temperatures and most animal fats solid, there are nevertheless notable exceptions such as cocoa butter, a solid vegetable oil and cod-liver oil, a liquid animal fat. There is considerable evidence that fats are synthesized from carbohydrates. Many fat-containing moulds and yeasts can be grown on culture media containing glucose, and in the animal kingdom the fattening of hogs on corn, both bear evidence in support of this theory. In general also, the formation of fats in seeds is preceded by carbohydrate storage.

Vegetable oils and fats may occur in various parts of the plant but as a general rule seeds contain larger quantities of fats and oils than do other plant parts. Seeds are the usual sources of fixed oils and as a few examples the following might be mentioned: cottonseed, linseed, sesame seed, hemp seed, coconut, castor beans, almond, etc. In a few instances other plant parts may yield considerable quantities of fixed oil (pericarp of the olive). In certain fungi (*e. g.,* ergot) fat is the characteristic reserve food material.

Chemically, the fixed oils and fats are glycerides of fatty acids having the general formula:

$$\begin{array}{l} CH_2\text{—O—CO—R} \\ | \\ CH\text{—O—CO—R}' \\ | \\ CH_2\text{—O—CO—R}'' \end{array}$$

If R, R′ and R″ are the same fatty acid radical the compound is called triolein, tripalmitin, tristearin, etc , as the case may be. If R, R′ and R″ are different ... of the glycerides in any
ent at the
d oils and

fats from any source may vary within certain limits.

It is usually true that the glycerides of unsaturated fatty acids are liquid while the glycerides of saturated fatty acids of sufficient chain length are solid

The predominance of either type in an oil will determine whether the mixture is liquid or solid Some of the more common fatty acids are·

Caproic	
Caprylic	
Capric	
Lauric	
Myristic	
Palmitic	
Stearic	
Arachidic	
Oleic	
Linoleic	
Linolenic	
Ricinoleic	$CH_3(CH_2)_5CHOHCH_2CH:CH(CH_2)_7COOH$

Fixed oils are sometimes classified into drying oils, semi-drying oils and non-drying oils. This classification is based upon their ability to absorb oxygen from the air. This oxygen saturates the double bonds to form oxides which may polymerize to form hard films. This property of drying oils is of great importance in the paint industry. The double bonds in the unsaturated fatty acids will also take up hydrogen under the proper conditions. Hydrogenation of the liquid oils will produce semi-solid fats which find extensive use as cooking-fats and shortenings.

The United States Pharmacopœia and the National Formulary include

of saponifiable matter present, including the amount of free fatty acids, the nature of the fatty acid radicals and the amount of mono-, and di-glycerides present, and the iodine number indicates the degree of unsaturation. Other

of which heat is used
of the oils Animal fa
steam, with or without
and may be separated b
and bleached with ozon

Fixed oils and fats
properties As ointmen
they may also be used as vehicles for other medicaments. A few, such as castor oil and chaulmoogra oil, have special therapeutic properties. In the arts and in industry they are used in the manufacture of soaps (sodium and potassium salts of the fatty acids), as drying oils in the manufacture of paints and varnishes and as lubricants. Fats also form an important class of foods.

One property of fixed oils and fats which can bear mention because it differentiates them from volatile oils, is the fact that fixed oils and fats leave a permanent stain on paper.

Waxes are usually defined as esters resulting from the condensation of high molecular weight straight-chain acids and high molecular weight, primary, straight-chain alcohols Such esters, of course, exist in waxes, but in reality waxes are better defined as mixtures of different molecular weight acids and alcohols. In addition waxes may also contain paraffins.

In plants, waxes are found in connection with the outer cell walls of epidermal tissue, particularly in fruits and leaves, where the function appears to be protection against the penetration or loss of water. Insects also secrete waxes, for various purposes. Carnauba wax (*Copernicia cerifera*) *and bayberry wax are examples of vegetable waxes and* Lac Wax and Beeswax are examples of insect waxes.

Waxes are employed in pharmaceuticals for "hardening" ointments and cosmetic creams and in the preparation of cerates. In industry and the arts they are used for protective coatings.

CASTOR OIL

Castor Bean or Castor-oil Seed (U. S. P. 1831 to 1842) is the ripe seed of *Ricinus communis* Linné. *Ricinus* is the Latin for a tick or a bug, applied because the seed resembles some bugs in shape and markings.

The plant is an annual in temperate climates to a tree, attaining the height of 15 meters, in the tropics. There are many forms of the plant with variations in the shape of the leaves, and the color, size and markings on the seeds. The fruit is a 3-celled spiny capsule, each cell containing an ovoid albuminous seed. The plant is indigenous to India. It is extensively cultivated in India, South America, the Levant, various parts of Africa, the East and West Indies, southern Europe and southern United States. The seeds have been found in Egyptian tombs The oil appears to have had only technical use until the eighteenth century when its medicinal use began.

The seed is ... from 8 to
18 mm. in lengt ... h
ish and brown,
caruncle at the son
flat or ventral side,
white, oily and bea
central, lenticular
the latter directed tc

Castor Oil (U. S. P. 1820 to date) is the fixed oil obtained from castor beans.

Castor Oil is prepared by passing the seeds through a decorticator having rollers with sharp cutting edges which break the testas, but do not injure the kernel; separating the testas by means of sieves and compressed air; and subjecting the kernels to pressure. The oil is steamed to destroy albumins, filtered and bleached. The yield of this "cold pressed" oil is about 35 per cent. The oil cake is steamed and a second expression is made which yields an oil of inferior quality.

Constituents.—Principally triricinolein; also isoricinolein, palmitin and dihydroxystearin; free ricinoleic acid, and its isomer, produced by hydrolysis in the duodenum are the cathartic principles. The seeds contain from 45 to 55 per cent of fixed oil, about 20 per cent of protein substances, consisting of globulin, albumin, nucleoalbumin, glycoprotein and ricin (a toxalbumin); an alkaloid, ricinine, several ferments; an ester composed of methyl alcohol and ricinic acid; sugar; a bitter principle; resin; and gum. The seed coat yields ... The toxalbumin, ricin, is not ... nains in the **Oil Cake**. It is

... most colorless; transparent; viscid; odor
... rid and usually nauseating. Consult the
tests.
... age dose, 15 cc It is also employed in
the manufacture of soaps and as a lubricant for internal combustion engines.

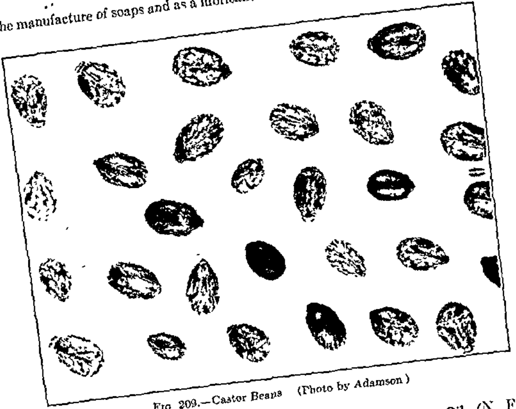


FIG 209.—Castor Beans (Photo by Adamson)

Hydroxyste... Hydrogenated Castor Oil (N. F. 1947 to date) ... passing hydrogen ... castor oil.

Fixed oils may be **hydrogenated** by passing hydrogen through the oil heated to 160° to 200° C. The ... of nickel or palladium ... unsaturated glycerides are more or less completely converted to saturated glycerides, which are solid at room temperature and very stable. Many such oils are used for culinary purposes.

Sulfated or Sulfonated Oils are obtained by reacting sulfuric acid with ...

... group reacts with the acid to form water The compound form is a sulfate of the fat.

DESCRIPTION.—Hydroxystearin sulfate is a pale yellow brown, semi-soft, ... It is miscible with water, alcohol, glycerin, ... petrolatums in all proportions. It is acid and contains up to 25 per cent of moisture.

For other constants and tests see the National Formulary.

STANDARDS.—Hydroxystearin sulfate, on a moisture-free basis, contains not less than 8.5 per cent and not more than 9.5 per cent of organically combined sulfur trioxide.

USES.—Medicinally in water-absorbent (hydrophilic) ointments, creams and pastes.

Riodine (NNR) is a 66 per cent solution in oil of an iodine addition product of castor oil. It contains about 17 per cent of iodine and is used as a substitute for the inorganic iodides. The dose is 0.4 to 1.2 gm. per day.

Croton Oil (U. S. P. 1831 to 1936; N. F. 1936 to 1947) is the fixed oil expressed from the seed of *Croton tiglium* Linné. *Croton* is from the Greek, meaning a tick or bug, and is used because the seed resembles a bug in shape; *tiglium* is from the Greek, meaning "to have a thin stool."

The plant is a small tree indigenous to tropical Asia and cultivated in India, Ceylon and the East Indies. The seeds resemble castor seeds in size and shape, but are dark brown in color. The kernel contains about 50 per cent of a fixed oil which is expressed by methods similar to those employed in obtaining castor oil. Besides the oil, the seed also contains a very toxic albuminous substance, crotin, a mixture of croton globulin and croton albumin, and comparable to ricin. Croton oil is produced in India and also in Europe. The ancient Hindu physicians were not acquainted with the use of the drug, which appears to have originated in China. Croton was introduced into Europe by the Dutch during the sixteenth century. Its use appears to have experienced periods of favor and disfavor.

Croton oil is a pale yellow or brownish yellow, somewhat viscid and slightly fluorescent liquid, with a faint characteristic odor. Croton oil is composed of the glycerides of the following acids: stearic, palmitic, myristic, lauric, oleic, tiglic, acetic, butyric, formic, and valeric. Croton oil is acid to litmus paper which has been moistened with alcohol. It forms a clear solution on heating with twice its volu [illegible] or less completely separates on cooling. [illegible] art distilled water and 2 parts croton oil, [illegible], does not solidify. Its saponification value is not less than 200 and not more than 215; its iodine value not less than 104 and not more than 110.

USES AND DOSE.—Croton oil is a drastic purgative. It is usually administered on sugar or bread crumbs. Average dose, 0.06 cc. It is the most violent of all purgatives and one of the most powerful local irritants.

Caution should be observed in handling croton oil as it causes pustular eruptions when applied to the skin.

Physic Nuts or Purging Nuts are the seeds of *Jatropha curcas*. The seeds are more or less oval, black and from 15 to 20 mm. in length. They contain about 20 per cent of a fixed oil and a substance comparable with ricin, known as curcin. Both oil and seeds are powerful purgatives. The bark of the tree, *Croton gubouga*, a species widely spread in Nyasaland, Rhodesia and Portuguese East Africa, is known as **Transvaal Croton Bark.** In external appearance the bark is 2 to 3 mm. thick, generally gray in color, with corky warts or longitudinal bands of cork. The bark possesses a persistently acrid, somewhat numbing taste.

The entire plant of *Cluytia si*[illegible] indigenous to South Africa, is reputed to be of value as an antidote for antl[illegible] meat, while the root is stated to [illegible] for snake-bite poisoning.

Stillingia or Queen's Root (U. S. P. 1831 to 1926; N. F. *1926 to 1947*) is the [illegible] *Stillingia* was applied in honor of Dr A. [illegible] *sylvatica* means wood-loving, in reference [illegible]

The plant is an herbaceous perennial growing in sandy soil from Virginia to Florida and west to Texas The roots are collected in August, deprived of the rootlets and sometimes cut into transverse or longitudinal slices and carefully

profession.

0 mm. in diameter; externally dark or scars few, internally cork thin, thick, soft, spongy, easily separable enchyma and numerous resin and , slightly lignified walls, h occasional strands of ains numerous, 5 to 45 microns in diameter, mostly single and spheroidal, with a central cleft, occasional rosette aggregates of calcium oxalate up to 70 microns in diameter; odor fai

volatile oil, from 3 to 4 per cent; an ac 10 to 12 per cent of tannin, starch; calcium oxalate. Total ash, 4 23 per cent; acid-insoluble ash, 1 2 per cent

Stillingia which has been stored for more than two years must not be used. Stillingia is an alterative and is usually combined with other drugs Average dose, 2 gm.

Euphorbia Pilulifera, Euphorbia, or Pill-bearing Spurge (N. F. 1916 to 1947) is the dried plant of *Euphorbia pilulifera* Linné *Euphorbia* is the Greek name of an African plant, named for Euphorbus, physician to King Juba, *pilulifera* means pill-bearing, alluding to the shape of the fruit. This is an annual herbaceous plant found growing in most tropical and sub-tropical countries It is common in the United States from Texas to Arizona. Most of the commercial supply, however, comes from India The plant is gathered at the time of flowering or fruiting and carefully dried.

For the description of the whole drug and of the powder see the National

glucosidal substance, several l ash, about 4 per cent; acid- some reputation as an anti-

ge (U S P. 1820 to 1882) is the root of *Euphorbia corollata*

Euphorbia Ipecacuanha or Ipecac Spurge (U S P 1820 to 1882) is the root of *Euphorbia ipecacuanha.*

The plants are herbaceous perennials producing stems up to 2 meters in height from the crowns of large branching roots. They are indigenous to the eastern United States from Canada to Florida, *E corollata* more to the north, and *E ipecacuanha* more to the south, and prefer dry sandy habitats The drugs

have been supplanted with other medicines.

Euphorbium is a dried resinous latex obtained from *Euphorbia resinifera*, a

KAMALA

Kamala, Rottlera or Glandulæ Rottleræ (U. S. P. 1863 to 1905; N. F. 1936 to date) consists of the hairs obtained from the capsules of *Mallotus philippinensis* Muller Argoviensis. *Mallotus* is Greek meaning

woolly or fleecy: the young branches, leaves and capsules are covered with fine hair. The plant is an evergreen shrub indigenous to south-eastern Asia and widely distributed throughout tropical Asia, Australia and the Philippines. The glandular hairy capsules are thrown into large baskets, rolled about and rubbed to remove the hairy covering. This impure powder is passed through a sieve to remove the larger fragments and tissues, other than the hairs. Most of the commercial supplies are exported from Indo-China to London, whence they are distributed.

DESCRIPTION.— ... yellowish red, glandular hai ... o a small quantity of vegetal

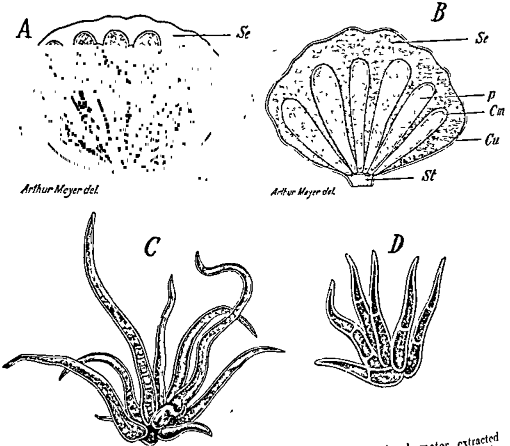


FIG 210 —Kamala. *A*, Glandular hair, 40 to 100 microns in diameter, extracted with chloroform and mounted in a solution of hydrated chloral *St*, short one-celled stalk; *Cu*, cuticle, *Se*, resinous secretion; *Z*, elongated, ovoid, somewhat spatulate separate cells, of which there are some 20 to 60 comprising the glandular hair. *B*, A longitudinal section through a glandular hair showing the position and arrangement of the individual cells *St*, short stalk, *Cu*, cuticle, *Se*, resinous secretion, *Cm*, wall of individual cells, *P*, granular cytoplasm Peltate groups of unicellular (*C*) and uniseriate (*D*) non-glandular hairs. (*A*, and *B*, after Meyer, *C* and *D*, after Vogl)

CONSTITUENTS —A dark brownish red resin, about 80 per cent by weight of the drug, ... rottlerin; isorottlerin; two reddi ... race of volatile oil, starch, sug ... ut 8 per cent; acid-insoluble ash, 6 per cent.

STANDARDS.—Kamala, when dried to constant weight at 100° C., yields not less than 66 per cent of non-volatile ether-soluble extractive, and not more than 6 per cent of acid-insoluble ash.

USES AND DOSE.—Kamala is a tæniafuge and vermifuge. Average dose, humans, 8 gm., fowl, 0.5 to 1 gm.

Elastica, Caoutchouc, or India Rubber (U. S. P. 1894 to 1916) is the prepared latex or milk juice of *Hevea braziliensis* and probably other species of *Hevea* trees indigenous to Brazil.

Incisions in the bark permit the flow of latex which is collected in small cups attached to the tree and frequently emptied. Formerly the latex was coagulated in thin layers on a paddle over open flame and became dark brownish in color. Now the rubber is precipitated from the latex by acids in water and the washed, curdy material is pressed in thin square porous sheets.

South American rubber was known to Columbus (second voyage). Its use spread widely after MacIntosh prepared waterproof cloth in 1823, and Goodyear discovered vulcanizing in 1842. Several species of *Hevea* were planted commercially after 1876. Before World War II, the United States used about one-half (700,000 tons) of the annual production, which came largely from the Dutch and English East Indies.

Synthetic Rubber was very rapidly developed in Germany and in the United States after the Japanese shut off the supply of natural rubber. Butadiene 1, 3-CH_2:CH.CH:CH_2, a petroleum hydrocarbon, also producable from alcohol and organic waste, when polymerized with styrene ($C_6H_5CH.CH_2$) from storax, but synthesized commercially from ethylbenzene, forms Buna S; if the polymerization be with acrylonitrile, CH_2:CH.(CN) the product is known as Buna N. Neoprene, formed by the polymerization of b-chloroprene, CH_2:CH.C(Cl):CH_2, derived from acetylene, contains 40 per cent of chlorine; it is superior to natural rubber as regards resistance to the action of light, ozone, and organic solvents. Many other types of synthetic rubbers are known and may be produced commercially.

Caoutchouc is insoluble in water, dilute acids, or dilute solutions of the alkalis; more or less soluble in chloroform, carbon disulfide, oil of turpentine, benzine and benzol. It melts at about 125° C., remaining soft and adhesive after cooling.

India Rubber consists chiefly of two hydrocarbons, one of which is ductile and readily soluble in chloroform, and the other elastic and less soluble in chloroform; it also contains 1 to 2 per cent of resin and volatile oil.

India Rubber retains its elastic and other properties and is not affected by heat, if it is first purified and then mixed with sulfur or sulfides. Ordinary rubber articles are prepared in this manner. Hard-rubber articles are manufactured from Borneo rubber, to which colophony, gum balata and caoutchouc are added, a number of mineral substances being added to cheapen as well as to color the final product.

Elastica is used pharmaceutically as a basis for plasters and in the manufacture of many surgical implements, syringes and catheters. It has no therapeutic action.

ALLIED PRODUCTS.—**African rubber** is obtained from several species of *Landolphia* and *Kickxia elastica* (Fam. *Apocynaceæ*). **Bahia rubber** is derived from *Hancornia speciosa* (Fam. *Apocynaceæ*). **Central American** or **Panama rubber** is obtained from *Castilloa elastica* (Fam. *Moraceæ*). **Ceara rubber** is the product of *Manihot glaziovii* (Fam. *Euphorbiaceæ*). **East India rubber** is the product of the commonly cultivated rubber plant, *Ficus elastica* (Fam. *Moraceæ*). **Guayule rubber** from *Parthenium argentatum* Gray, was extensively produced in southern California and northern Mexico during World War II. **Penang** or **Borneo rubber** is the product of several species of *Urceola* (Fam. *Apocynaceæ*).

Cascarilla Bark (U. S. P. 1820 to 1905; N. F. 1916 to 1926) is the dried bark of *Croton eluteria*, a tree-like shrub indigenous to the West Indies. The com-

mercial supplies are chiefly obtained from Nassau, Bahama Islands. The bar is now used to a limited extent in medicine On account of the aromatic odo which it emits on burning, it is used in fumigating mixtures It is largely use in flavoring liquors and in scenting tobacco. It occurs in quills or transversel curved pieces, 4 to 12 mm. in width, and 0.2 to 3 mm. in thickness; externall grayish brown with patches of foliaceous lichens having minute black apotheci longitudinally wrinkled and transversely fissured; inner surface dark brown longitudinally striate; fracture short,
ing an easily exfoliated cork; primar
whitish oil cells and the brownish re
brown with narrow, white medullary
strands of leptome and secretion cells
...aining
millim

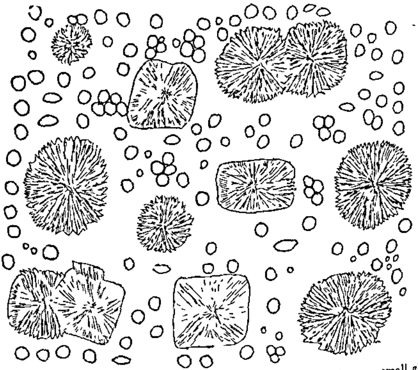


FIG. 211.—Microscopic appearance of latex in *Ficus elastica*, showing small globules and sphero-crystals which separate soon after the removal of the fresh latex. (From a drawing by Hogstad)

Cassava Starch, Para or ... from the ... thickened roots of the bitter ... (*Manihot palmata*), perennial herbs native of South ... cultivated in the West Indies, tropical South America and to some extent in Florida and other southern states. The plants are very easily grown and produce very large r... At harvest time the roots are dug, washed, c... grains are released and finally obtained ... in the manufacture of potato starch. T... in Brazil from the root of the bitter cas... d in the process of washing and dr... ade from the sweet cassava. As this starch is sold very often at a price below even that of corn starch, it is used to some extent in the arts, chiefly as a sizing for cotton fabrics.

or
sh
circular or radiating cleft (Fig 40).

Tapioca (U. S. P. 1820 to 1882) is formed by heating the cassava starch while it still contains a maximum degree of moisture. It is heated upon iron plates, first at a low temperature, which is gradually increased until the starch grains are agglutinated into the familiar form of "pearl tapioca" Any other starch, if moistened and subjected to the same process of heating, will result in the production of forms similar to those of the genuine article. Tapioca is chiefly used in the making of puddings, and useful as a nutrient for convalescents.

ANACARDIACEÆ, OR SUMAC FAMILY

This family consists of about 400 species of trees or shrubs, sometimes climbing and very abundant in the tropics and subtropics, a few being found in the temperate zones. The typical genus, *Rhus*, of which there are a number of species found in the United States, is characterized by compound leaves, small greenish white or yellow flowers, occurring in terminal panicles, and drupaceous, often crimson-colored fruits. All of the plants of this family possess resin canals, which are situated in the phloem portion of the vascular bundle of the axis and leaves. In some few cases these are also found in the medullary rays, pith and cortex. In addition, tannin sacs occur more or less abundantly and occasionally lysigenous mucilage cavities are present. More or less crescent-shaped groups of bast fibers occur in the pericycle, enclosing on the concave side, a large resin canal, occasionally the pericycle is a composite and continuous ring of sclerenchyma. The non-glandular hairs are mostly unicellular. Glandular hairs of a number of specific forms are developed.

MASTIC

Mastic or Mastich (U. S. P. 1863 to 1916, N. F 1916 to date) is the concrete exudation from *Pistacia Lentiscus* Linné. Mastic is from the Greek, meaning to chew; *Pistachia* is from the Persian *pistah*, the name of the pistachio tree; *lentiscus* refers to the lenticular cavities into which the resin is secreted. The plant is a shrub or small tree indigenous to the Mediterranean region, and cultivated in the Grecian Archipelago, especially on the Island of Scio. The resinous juice collects in cavities in the inner bark. Long incisions are made in the trunk and larger branches through which the resin exudes and finally collects in small tears on the outside The origin of the use of mastic is lost in antiquity Both Theophrastus and Pliny mention it Mastic has long been chewed by Oriental women as a breath sweetener and even today is a common article in the Oriental bazaars. Its employment in medicine dates back to about the thirteenth century.

DESCRIPTION.—Somewhat globular or ovoid tears, 3 to 7 mm in length, moderate yellow to pale gr[illegible]
comparatively free from a
plastic when chewed; odor
The acid number is not less than 50.

CONSTITUENTS.—About 90 per cent of a resin, consisting of α-resin (mastichic acid), which is soluble in alcohol, and β-resin (masticin), which is insoluble in alcohol; a volatile oil, 1 to 2.5 per cent, with the balsamic odor of the drug and consisting chiefly of *d*-pinene. *A small quantity of a bitter principle,* which is soluble in hot water and is precipitated by tannin, is also present. Total ash, about 0.35 per cent; acid-insoluble ash, about 0.1 per cent.

FIG. 212.—Mostly non-glandular hairs and a few of the small glandular hairs covering the surface of the fruits of several species of *Rhus* *g*, hairs on *Rhus glabra*, being more or ... late and occasionally narrow, elliptical ... ing long and needle-like. ... *realis*, being intermediate ... elongate spatulate and ... gth

STANDARDS.—Mastic yields not more than 3 per cent of ether-insoluble residue and not more than 20 per cent of alcohol-insoluble residue. It contains not more than 1 per cent of foreign organic matter and yields not more than 0.25 per cent of acid-insoluble ash.

USES AND DOSE.— ... tion it is a protective.

Various other spec ... orthern Africa yield resins resembling ma ... from the Peruvian Peppertree (*Schinus molle*) Similar resins are ... other genera of the *Anacardiaceæ*, as *Astronium* and *Semecarpus*.

Chios Turpentine is ... *terebinthinus*. It ... of pinene) and 80 ...

Rhus Glabra o... 1916 to 1926) is the fruit of *Rhus glabra*, a smooth glaucous shrub, indigenous ... U. S. P. 1820 to 1916, 1926 to 1936; N. F. to Canada and the United States, extending as far west as Arizona. The dry drupe is superior, nearly globular, flattened, 3 to 5.5 mm. in diameter, 2.5 mm. in thickness, and with a slender peduncle about 2 mm. in length, reddish externally, very pubescent; endocarp smooth, shiny, light red; 1-locular, 1-seeded; inodorous, taste acidulous and astringent. The gland ... hairs which are the characteristic ...

Rhus Glabra contains ... cium and potassium mala... varies from 6 5 to 8 per ce... about 2 79 per cent; acid-insoluble ash 0.7 per cent It is an astringent and a tonic ... of malic acid,

The **fruits** of the staghorn sumac, *Rhus typhina*, a shrub very abund... the eastern United States, have replaced to some ext... The drupes of these two plant... size but ...

... n ... i ... t ... Rhus Glabra. ... acid, ranges up to 11 22 per cent, being much higher ... thicker walls ... in length,

The leaves of *Rhus glabra* contain from 16 to 25 per cent of tannin. The total **galls** formed on the petioles and leaves resemble the Chinese or Japanese galls and contain about 60 per cent of tannin and some gallic acid

Rhus Toxicodendron, Poison Ivy or Poison Oak (U S. P. 1820 to 1905) is the fresh leaflets of *Rhus toxicodendron* (*Rhus radicans*), a woody vine common throughout the United States. It either trails over the ground or climbs by means of aerial roots or remains shrub-like The leaves are 3-foliate, the leaflets being ovate, acuminate, nearly entire, inequilateral, 3 to 20 cm long and with short stalks, inodorous, slightly astringent, saline and acrid in taste The flowers are green and in loose axillary panicles. The fruit is a globular, glabrous, grayish drupe.

The poisonous constituent has been thought to be a volatile principle, or a resin emulsified in the latex, or a protein producing an anaphylactic reaction in certain humans A phenolic oily resin, named **toxicodendrol** ... all of the poisonous *Rhus* species, has bee... It is not volatile ... phenolic groups, ... nt in readily It is pro... ient by exposure to air ... has alkali hydroxides, and ... substance may be det... mounted in an alcoho...

Toxicodendrol occur... plant is injured, it causes dermatitis ... of the plant ... skin It may be ... It is not infecti... e quantities of it ... e persons differ in ... to the poison. ... cause dermatitis ... minute injection of acetone extracts of poison ivy leaves appears to confer protection against the dermatitis, and to shorten the course and mitigate the symptoms of the dermatitis already developed. Probably ... Desensitization by intramuscular

Dried poison ivy leaves are of questionable medicinal value The drug is said to possess narcotic and antirheumatic powers

Rhus vernix, commonly known as **Poison Sumac, Poison Elder or Poison Dogwood**, is poisonous, like *Rhus toxicodendron*, and contains the same prin-

ciples. It is a shrub or small tree, found in swamps in the United States and Canada. The leaves are 7- to 13-foliate, with obovate or oval, acuminate, entire leaflets; the flowers are small, green, and in axillary panicles; the fruit resembles that of *Rhus toxicodendron*.

Other species of *Rhus* are also poisonous, as the western poison oak (*R. diversiloba*) of the Pacific Coast, and the **Japanese Lacquer** or Varnish tree (*R. vernicifera* and *R. succedanea*). The lacquer trees grow wild in both China and Japan, where they are also cultivated. The specific name *vernix* means "varnish." The lac is obtained by incising the bark and removing it with a pointed spatula. The grayish white emulsion, which contains toxicodendrol, is strained and on exposure to air it changes to brown, becoming finally black. This change is due to the oxidizing enzyme, laccase. When Japanese lac is thinned with camphor, or mixed with linseed oil, on drying in a moist atmosphere, it forms the most indestructible varnish known. Various pigments are used, as vermilion, gamboge, acetate of iron and other substances. The best glossy black colors are obtained by the addition of iron.

The tree, *Lithræa caustica*, found in Chile, causes an inflammation of the skin like that caused by *Rhus toxicodendron*. The plant contains a resin and a volatile oil. The poisonous properties are ascribed to a volatile substance resembling cardol.

Rhus semilata produces **Chinese Galls**, excrescences formed as a result of the stings of an aphis. **Japanese Galls** are similar formations occurring on *Rhus japonica*.

Anacardium.—West Indian Cashew is the fruit of *Anacardium occidentale*, a tree indigenous to the West In
The fruit consists of a fleshy, pe
kidney-shaped, drupaceous nut;
breadth and thickness; of a very dark brown color, nearly smooth, easily
containing large ellipsoidal balsam canals;
oat and enclosing a
eddish, oily, vesicat-
ble in water, soluble
l sulfuric acid, the
latter solution becoming colored red, also anacardic acid, and tannic acid. The seeds contain from 40 to 50 per cent of a fixed oil, consisting mostly of glycerides of oleic acid with some stearic acid and cholesterin. Anacardium has been used as a vesicant and as an escharotic. It also is said to be a vermifuge. The oil is administered as a vermifuge in an average dose of 0.2 gm. The kernel, raw or roasted, is edible. The fleshy receptacle of the West Indian cashew after maturing is sweet and edible. In Brazil, a wine, said to resemble Madeira wine, is made from it.

Oriental Cashew-nut is the fruit of *Semecarpus anacardium*, a tree indigenous to northwestern India and widely distributed in southern Asia. The fruits resemble those of the West Indian cashew-nut and contain similar principles, viz., cardol, anacardic acid and tannic acid. They also contain an alkaloid, chuchunine, which resembles strychnine in its action.

The resinous juice of the stem furnishes a varnish; and the fixed oil from the seeds is used in India for a floor dressing, to protect from the attacks of white ants.

Pistachio Nut, or Green Almond, is the seed of *Pistacia vera*, a tree indigenous to western Asia and cultivated in the Mediterranean countries and also in California. These seeds are extensively used in confectionery and are from
and consist of
ie carmine or
i the addition
s with porous
d other seeds
walls of the inner epidermal layer of the seed coat. Almon
dyed with coal-tar colors are sometimes substituted for the genuine article.

Prinos or Black Alder (U. S. P. 1820 to 1894) is the bark of *Prinos verticillatus* Linné (*Ilex verticillata* Gray) (Fam. *Aquifoliaceæ*).

This black alder or winterberry is a shrub 2 to 3 meters high, growing in swampy ground in Canada and northern United States. The bark is thin, in slender pieces, or in fragments, brownish with light-colored lichens with dark apothecia. It is inodorous, with a bitter astringent taste. It contains tannin and an amorphous bitter principle. It has been used as an astringent, tonic and alterative. Dose, 2 gm.

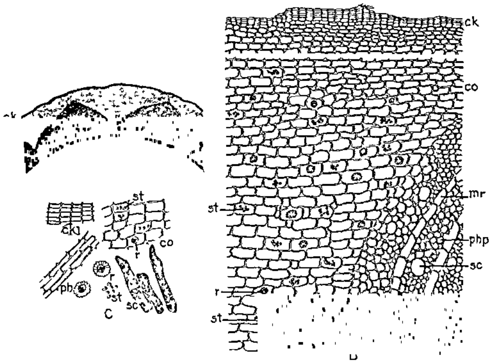


FIG. 213.—Euonymus. *A*, lens view of the bark in transverse section: *ck*, thin layer of cork, *co*, broad cortex, penetrated by broad wedges of phloem (*ph*). *B*, Transverse section of outer portion of bark: *ck*, cork of small cells with thin nearly colorless lignified walls; *co*, cortex of tangentially elongated parenchyma, bearing starch and calcium oxalate rosettes, a portion of the phloem area showing curved, 1-cell wide medullary rays (*mr*), sieve strands and phloem parenchyma (*php*), and secretory cells (*sc*). *C*, Elements of the powder: cork fragments (*ck*), fragments of parenchyma from the cortex (*co*) and phloem (*ph*), calcium oxalate rosettes (*r*), mostly about 30 microns in diameter, starch (*st*) nearly spherical and up to 21 microns in diameter, elongated, yellowish to brownish amorphous masses of caoutchouc latex (*sc*) or latex cells. (Drawings by G. Bruch.)

CELASTRACEÆ, OR STAFF TREE FAMILY

The plants are trees, shrubs or woody climbers, represented by about 45 genera and 450 species, which are widely distributed. The leaves are simple, the flowers are small and regular, the fruit is a somewhat fleshy dehiscent pod, and the seeds usually have a reddish or purplish aril. The plants are furthermore distinguished by the development of caoutchouc-containing elements in the phloem. These resemble laticiferous tubes, having narrow lumina and caoutchouc-like contents, which are soluble in chloroform, ether and similar solvents. They are frequently so abundant, as in *Euonymus*, that when the bark is broken the

fragments remain connected by the tough elastic threads. The cork-wings, which are peculiar to a number of species of *Euonymus*, are due to the development of cork in the parenchyma of the cortex. This usually arises at four different points, thus elevating the epidermis and giving the branches a 4-angled or slightly winged character.

Euonymus or Wahoo Bark (U. S. P. 1863 to 1916; N. F. 1916 to 1947) is the dried bark of the root of *Euonymus atropurpureus* Jacquin. *Euonymus* is from the Greek meaning "good name;" the common name of the plant "Spindle Tree," well describes the form of growth; *atropurpureus* means "dark purple," in reference to the colo[illegible] shrub or slender tree growing in the east[illegible] introduced the drug to [illegible] works on domestic medicine.

The drug [illegible] 4 m[illegible] sca[illegible] fre[illegible] bark, inner surface light gray, longitudinally striate, somewhat porous; fracture short, with silky, projecting caoutchouc strings; [illegible] and with [illegible] ck cork

The stem-bark occurs in very long, fibrous [illegible] and should be rejected.

Structure and Powder.—See Figure 213.

The drug contains volatile oil, 1.3 per cent; a phytosterol glucoside; dulcitol, starch; tannin; a mixture of fatty acids; furan-α-carboxylic acid; euonymol, euonysterol, and atropurol. Total ash, about 8.75 per cent; acid-insoluble ash, about 2 per cent.

Euonymus is a mild purgative. It has a mild effect upon the heart, similar [illegible] m. [illegible] h (*Ptelea trifoliata*) is occasionally sub[illegible] sely curved pieces from 3 to 4 mm. in [illegible] h transverse ridges and grayish white lenticels; fracture short; broken surface pale yellow and waxy.

Allied Drugs.—*E. europæus* and other species of *Euonymus* are also used in medicine and probably contain the same constituents.

ACERACEÆ, OR MAPLE FAMILY

This family consists of shrubs or trees, represented chiefly by the genus *Acer*, of which there are about 100 species, growing abundantly in the United States, Canada, China and Japan. They are extensively used as shade trees and a great many horticultural varieties have been produced, those of Japan being known for their highly dissected leaves and their brilliant colorings. The wood of the maple is extensively employed in the manufacture of furniture and flooring and for a variety of purposes. The sap of the Sugar or Rock Maple (*Acer saccharum*) is the chief source of **Maple Sugar**. It is produced in New England, especially Vermont but also in New York, Ohio, Indiana, Michigan, etc.

The trees are "tapped" in early spring when the sap begins to rise; it is collected through spiles driven into the sap wood, evaporated in kettles over open fires and enters market as syrup or loaf sugar. The unrefined products are much more tasty than the refined sugar. The yield per tree is 3 to 6 pounds of sugar annually, and a "sugar grove"

may be worked for many years without harm to the trees. A small amount of sugar is also obtained from the Black Sugar Maple (*Acer saccharum nigrum*) and the Silver or White Maple (*Acer saccharinum*).

The family yields no drugs but the reader is referred to Viburnum Opulus under which the Mountain Maple (*Acer spicatum*) is discussed as an adulterant.

SAPINDACEÆ, OR SOAPBERRY FAMILY

This is a large family of over 1000 species, chiefly tropical woody climbers. They are especially characterized by the presence of glucosidal saponins which have the property of frothing with water, so that some of them have been employed as substitutes for soap, as the fruits of *Sapindus*, a tree widely distributed from Arizona to northern Mexico. Several forms of secretory cells are also found in this family, one being more or less spheroidal or irregular in shape and another in the form of elongated tubular cells, frequently arranged in uniseriate rows. The contents vary from yellowish brown to brownish black and apparently contain saponin. Some of the secretion cells give a reaction with ferric salts for tannin. The walls of the epidermal cells are frequently modified to mucilage, and the cells on the dorsal surface may be papillose. Glandular and non-glandular hairs occur in a number of specific forms.

dried in the sun or over fires.

Guarana is used in the preparation of a beverage which is used like tea and coffee by the people of Brazil. Guarana was introduced into France from

consisting mostly of irregular masses of parenchyma cells, containing more or less altered starch grains; unaltered starch grains, from 10 to 25 microns in diameter, spheroidal, ellipsoidal, broadly ovoid or polygonal in shape; occasionally narrow, elongated, sclerenchymatous cells, with thick, yellowish and

annic acid),
; a volatile
cent; acid-

Guarana yields not less than 4 per cent of anhydrous caffeine and not more than 0.5 per cent of acid-insoluble ash. Place a drop of hydrochloric acid on

; due to the caffeine that is present. It is also an astringent and a tonic. Average dose, 2 gm.

RHAMNACEÆ, OR BUCKTHORN FAMILY

This is a family of 45 genera and over 500 species, consisting of shrubs or trees, often woody climbers, and rather widely distributed. The leaves are mostly simple and stipulate, *the flowers are small and regular* and the fruit is a drupe or capsule. *The twigs of some of the species,*

Fig. [illegible] ...ata bark in Washington forests. Illustrating a method employed in commercial collection and the dense forest in which the collector must work (*After Johnson and Hindman*)

as *Rhamnus cathartica*, possess stout thorns, hence the name *buckthorn* as applied to this species and the family. Many of the plants are characterized by the presence of methyl-anthraquinone derivatives, which give a bright red color with solutions of the alkalis. These *derivatives* are found in the *medullary* rays and distributed among the parenchyma

cells of the cortex. Some of the plants of this family contain idioblasts having brown contents, secretory cavities containing a brown amorphous substance, or mucilage cavities. The latter when present are distributed in the parenchyma of the cortex and in the veins of the leaves. The walls of the epidermal cells sometimes are modified to mucilage. The leaf-teeth are differentiated into glands and the non-glandular hairs are unicellular, uniseriate or stellate. Glandular hairs do not occur.

FIG 215.—Transporting cascara bark on pack horses to wagon road (After Johnson and Hindman.)

CASCARA SAGRADA

Cascara Sagrada (U. S. P. 1894 to date) is the dried bark of *Rhamnus purshiana* DeCandolle It should be kept dry for at least one year before being used in medicinal preparations The name *Cascara Sagrada* is Spanish for sacred bark, *Rhamnus* is the ancient classical name for buckthorn; *purshiana* was given in honor of the German botanist, Fred Pursh. The plant is a tree attaining the height of 20 meters, indigenous to the Pacific Coast of North America. Most of the present-day market supply comes from Oregon, Washington and southern British Columbia. Collections are made during the spring and summer. The wild trees are scattered in the native forests on the mountains and collectors usually operate on foot and horseback. The bark is stripped from the tree by making longitudinal incisions about 4 inches apart and peeling off sections which tend to roll into large quills The trees are often felled and the bark also removed from the larger branches The bark is sacked and conveyed on horseback and truck to suitable places, often saw mill plat-

into medicine in 1877 by Dr. J. H. Bundy after which it rapidly became a favorite, and today is in demand all over the world.

Description, Structure and Powder.—See Figures 218, 219, 220 and the U. S. Pharacopœia.

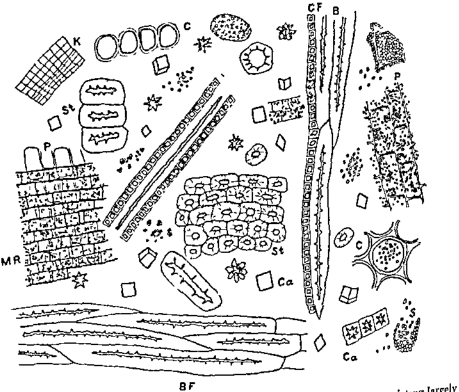


Fig. 220.—Powdered Cascara Sagrada. Light brown to olive brown, consisting largely of groups of bast fibers (*B*) with their associated crystal fibers (*CF*), the latter especially prominent in phloroglucin T S or chloral T.S mounts, almost equally numerous are the groups of stone cells (*St*) which are frequently associated with parenchyma containing large rhombohedra of calcium oxalate (*Ca*), fragments of parenchyma and medullary ray cells colored red upon the addition of solutions of the alkalis; starch grains (*S*) either ... from 3 microns to ... osettes from 6 ... l fragments of

Constituents —George D. Beal and co-workers in a series of reports (A. Ph A. J , 1922 to 1942) have presented much light upon this difficult subject.

Upon hydrolysis of the constituent cascara glycosides rhamnose and dextrose are found in the approximate ratio of 1:1, and the rate of hydrolysis indicates that these sugars are present in true glycosidic linkage. Among the aglycones obtained from cascara are. ... none.

Emodin or frangu
Iso-emodin, 3, 5,
?-emodin, 1, 6, 8-trihydroxy-2-methyl-anthraquinone
Aloe-emodin, 1, 8-dihydroxy-anthraquinone-3-carbinol.
Methylhydrocotoin, 2, 4, 6-trimethoxy-benzophenone.
Chrysophanic acid, 4, 5-dihydroxy-2-methyl-anthraquinone.

The total anthraquinones found in cascara sagrada was 3 81 per cent and 1.11 per cent were in the free state Dialysis is the most expedient method of separating the inert material from the active ingredients of the fluidextract of

cascara. The activity of the fluidextract was not altered appreciably by: (*a*) complete hydrolysis of the glycosides present, or (*b*) by extraction of the free anthraquinones

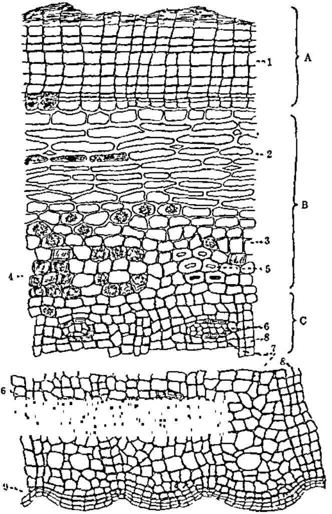


FIG. 221 Transverse section of the bark from a ten-year-old stem of *Rhamnus californica* *A*, Outer bark, *B*, middle bark, *C*, inner bark 1, Cork, the outermost rows compressed, 2, collenchyma, strongly elongated tangentially with much-thickened walls, 3, parenchyma with numerous rosettes and prisms of calcium oxalate 4, group of stone cells, 5, unlignified primary bast, 6, lignified secondary bast with crystal fibers, 7, phloem parenchyma, 8, medullary ray, 9, the cambium, the edge showing the waviness characteristic of this bark. (Drawing by E. N Gathercoal)

A mixture of 10 mg. each of aloe-emodin and emodin plus 5 mg of chrysophanic
of the
action
explan
the relatively poor activity of any of the purified fractions thus far studied.

The bark also contains rhamnol arachidate, a fat, a bitter principle, several resins; tannin; glucose, starch; calcium oxalate. Total ash, about 5.2 per cent; acid-insoluble ash, about 0 15 per cent.

Cascara bark contains from 0.0137 to 0.0223 per cent of manganese. Many other laxative drugs contain manganese, and Westman and Rowat have suggested the establishment of a manganese number for the valuation of the extracts of this class of drugs.

STANDARDS AND TESTS.—Cascara contains not more than 4 per cent of foreign organic matter. It should be collected at least one year before being used for making medicinal preparations. Cascara gives a red color when treated with ammonia T.S. If 0.1 gm. of powdered cascara is boiled with 10 cc. of water, cooled, filtered, the volume of the filtrate made up to 10 cc. and 10 cc. of ammonia T.S. added, an orange-yellow color is produced in the mixture Cascara Sagrada produces a yellowish red color with the modified Borntrāger test as given in the Pharmacopœia.

USES AND DOSE.—Cascara Sagrada is a tonic laxative. Its bitterness also makes it somewhat stomachic. Its principal use is in the correction of habitual constipation where it not only acts as a laxative but restores natural tone to the colon. The bitter taste and the activity is considerably reduced by treating cascara sagrada extracts with alkaline earths or magnesium oxide. Average dose, 1 gm.

Cascara Sagrada from *Rhamnus californica*, a shrub indigenous to southern California and the neighboring states, yields a bark which closely resembles

from 10 ... is distinctly crenate or undu- late, as ... ; nearly all of the cells ... the oxymethyl- anthraq ... the solutions of the alkalis.

Frangula or Buckthorn Bark (U. S. P. 1882 to 1926; N. F. 1926 to 1947) is the dried bark of *Rhamnus frangula* Linné. The specific name *frangula* means "brittle," in reference to the brittle stems of this species. The plant is a shrub attaining the height of about 5 meters growing in Europe and western Asia. ... and branches during the spring and early ...

medicinal preparations. Most of the commercial supply comes from ... and Russia. Decoctions of the bark have been used from an early date for cathartic purposes. It seems, however, not to have come into professional medical use until the nineteenth century.

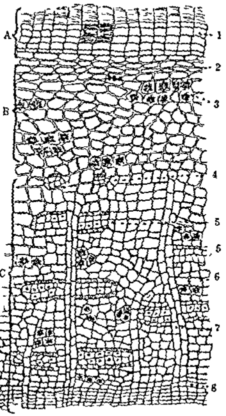
DESCRIPTION.—In single or double quills often crushed and flattened, bark 0.3 to 1 mm. in thickness; outer surface dusky red to light olive brown, with numerous light-colored, transverse lenticels 1 to 5 mm. in length, and with grayish patches of foliaceous lichens bearing dark-colored apothecia; older bark ... dusky yellow- ish or ... reddened by so... ...rs in the inner bark.

STRUCTURE.—See Figure 222.

POWDER.—Y... taste slightly bitter, astringent and acrid; bas... with very thick lignified walls and num... th crystal fibers; calcium oxalate in rosettes or monoclinic prisms from 7 to 15 microns in diameter; starch grains nearly spheroidal, 3 to 10 microns in diameter, not numerous; parenchymatous cells with yellowish or purplish brown contents, colored red by solutions of alkalis. Stone cells are absent (distinction from cascara sagrada).

Frangula contains a glucoside, frangulin, which occurs in yellow crystals,

insoluble in water and nearly so in alcohol, giving a bright purple color with



crystals, 4, the earliest secondary bast, 5, secondary bast of later growth with accompanying crystal fibers, 6, phloem consisting mostly of parenchyma with some rosettes of calcium oxalate, 7, medullary ray, practically free from crystals, 8, cambium. (Drawing by E N Gathercoal)

When 0 1 gm. of powdered frangula is boiled with 10 cc of water, cooled and filtered, the filtrate is colored deep red by the addition of ammonia water Frangula produces a distinct cherry red color with the modified Bornträger's test

'n the United States it has been veterinary practice. substituted for *R. frangula*. It *the bark being from 1 to 3 mm.* rown, having numerous grayish 1 to 2 mm in width; the inner udinally striate; the fracture is short-fibrous; the odor slight, and the taste, bitter and astringent. The older

pieces are distinguished by having a deeply fissured cork and groups of stone cells. In the younger bark the medullary rays are from 4 to 7 cells in width.

The bark of *R. cathartica* (see Fig. 223) possesses cathartic properties and has been used like frangula.

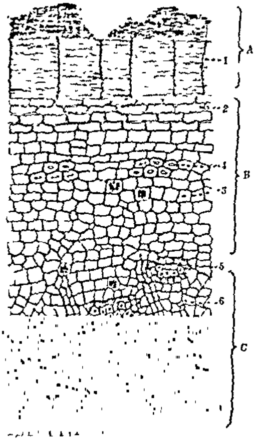


FIG 223 —Transverse section of the bark of *Rhamnus cathartica* from a four-year-old stem *A*, Outer bark, *B*, middle bark, *C*, inner bark. 1, Cork, many rows of narrow cells much elongated tangentially, 2, collenchyma of a few poorly differentiated rows, 3, parenchyma with some calcium oxalate rosettes; 4, unlignified primary bast, 5, lignified secondary bast with crystal fibers; 6, phloem parenchyma, 7, medullary ray, 8, cambium (Drawing by E N. Gathercoal.)

Rhamnus Cathartica, Buckthorn Berries, or Baccæ Spinæ Cervinæ (U. S. P. 1820 to 1831, N. F 1916 to 1947) is the dried, ripe fruit of *Rhamnus cathartica* *Linné* The specific name *cathartica* refers to the purgative properties of the drug. The plant is a thorny ... northern Africa and central Asia, but widely distributed ... States. The ripe fruits are co... Hungary. Buckthorn fruits ... **thorn or Hartshorn** before the Norman Conquest ... thirteenth century prescribed a preparation of the berries under the name of Syrup of Buckthorn

For the description and structure of the fruits and the powder see Figure 224 and the National Formulary, Seventh Edition

Buckthorn Berries contain rhamno-emodin, apparently the most active ... in golden yellow ... in yellow ... ge needles;

violet anthocyanin; and chlorophyll.

Rhamnus Cathartica, when macerated in water, assumes its original globular shape, about 1 cm. in diameter. The expressed pulp is colored red by acids and greenish yellow by alkalis. If an aqueous infusion of the fruit is shaken with ether and the separated ethereal layer then shaken with diluted ammonia water, the latter becomes cherry-red.

Rhamnus Cathartica is a purgative. Average dose, 1 gm.

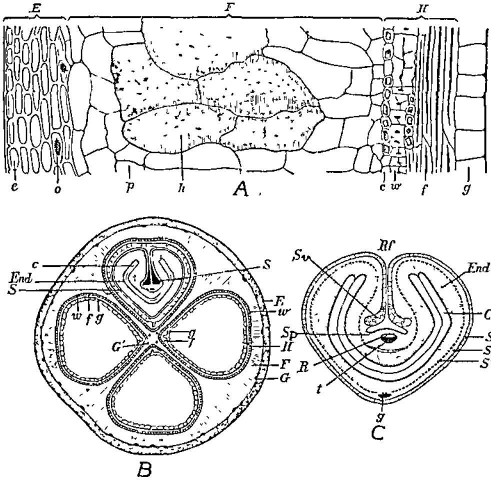


FIG. 224 Rhamnus Cathartica. *A*, Cross-section through wall of the fruit. *E*, pericarp, *F*, sarcocarp, *H*, endocarp, *e*, epidermis, *o*, calcium oxalate in cells of hypodermis, *p*, parenchyma, *h*, secretion cells containing a substance which is insoluble in alcohol or hydrated chloral solutions, soluble in solutions of potassium hydroxide and colored reddish brown or greenish with ferric chloride solutions, *c*, calcium oxalate cells of endocarp, *w*, sclerotic cells, *f*, sterome cells. *B*, Cross-section of entire fruit showing one seed. *E*, *F*, *H*, *g*, *f*, *w*, as in *A*, *S*, seed coat, *S'*, outer wall of seed coat, *End*, endosperm, *c*, cotyledons, *G*, vascular bundle. *C*, cross-section of a seed. *S*[1], *S*[2], *S*[3], different layers of the seed coat, *R*, vascular bundle of raphé, *t*, position of vessels of mestome strand, *g*, mestome strand, *Rf*, cleft in which raphé is situated, *End*, endosperm, *C*, cotyledons, *Sc*, cells with thick walls, *Sp*, parenchymatous cells. (After Meyer.)

ALLIED DRUGS. The fruits of *Rhamnus cathartica*, as well as those of *R. infectoria* (known as **French Berries**) and of *R. saxatilis* (called **Persian Berries**) have been used as yellow dyes. The fruits of several species growing in China yield a green indigo.

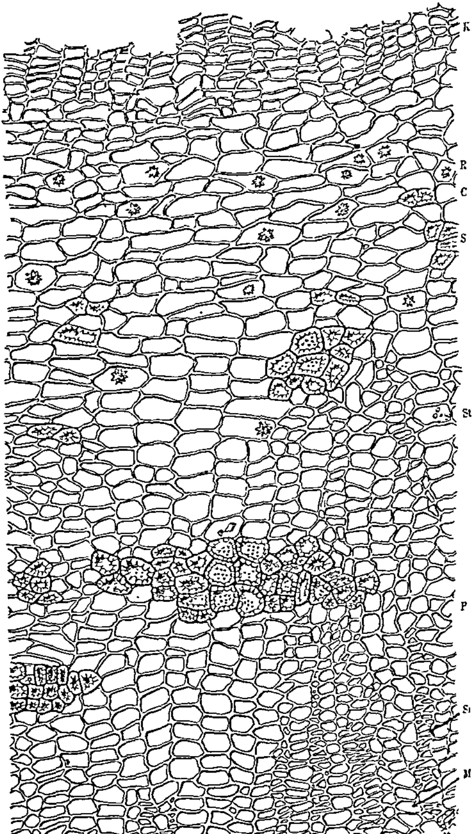


FIG. 225 —*Ceanothus americanus*.—Transverse section of root bark· *K*, cork; *C*, cortex; *P*, phloem; *R*, rosettes of calcium oxalate, *St*, starch; *S*, stone cells; *Si*, sieve, *M*, medullary rays. (Drawing by E. H. Wirth.)

Ceanothus, New Jersey Tea, or Red Root, is the dried bark of the root of *Ceanothus americanus*, a branching shrub, 6 to 12 dm. high, of the eastern and central United States and Canada. The large woody root with many branches is terminated with a knotty crown producing numerous slender stems. The plant has long been known as an astringent, and during the Revolution the dried leaves served as a substitute for tea. Recently the drug has been shown to possess marked blood-coagulative powers when administered by mouth The bark occurs in short quills or curved pieces, 1 to 3 mm. thick, grayish to reddish brown, smooth or roughened by longitudinal furrows, inner surface usually reddish brown, striate or smooth; short, uneven granular fracture; odorless; taste astringent and bitter The structure is shown in Figure 225

Ceanothus contains tannin 10 per cent, phlobaphenes, resin, oil, and a mixture of alkaloids, one of which has been crystallized. Total ash about 2 per cent, acid-insoluble ash about 0.15 per cent. It is a hemostatic and blood coagulant.

VITACEÆ, OR VINE FAMILY

Shrubs, usually climbing by tendrils, with small, regular, greenish, usually polygamous flowers, the stamens as many as the valvate petals

ate climate of the world.

Raisins (U. S. P. 1820 to 1882) are the dried mature fruit of *Vitis vinifera* Linné. The European Wine Grape, indigenous to western Asia, has been widely cultivated in Europe from a very early period, and in California since the Spaniards introduced it. As the grapes ripen, the stems are partially cut across and the fruit then partially dries as it ripens After several weeks the bunches of fruit are cut off and fully dried in the sun; or the fully ripened fresh fruit is

WHITE WINES—

Vinum or Wine, U S P. 1820 to 1851.

Vinum Album or White Wine, U. S P 1851 to 1863, 1882 to 1916

Vinum Xericum or Sherry Wine, U. S. P. 1863 to 1882; N. F. 1916 to 1926, 1947 to date.

RED WINES—

Vinum Rubrum or Red Wine, U S. P. 1851 to 1863, 1882 to 1916.

Vinum Portense or Port Wine, U S. P. 1863 to 1882.

BRANDY—

Spiritus Vini Gallici or French Brandy, U. S. P. 1851 to 1916

Spiritus Vini Vitis or Brandy, U. S. P. 1826 to 1947; N. F. 1947 to date.

Fresh ripe grapes separate under pressure into juice or "must" and husk-seeds or "marc." If the juice is fermented after filtration, a light-colored wine is produced, if it be fermented before filtration, a dark colored or red wine is formed.

The amount of sugar in grapes (dextrose) varies from 12 to 30 per cent, the larger quantity being produced in warmer climates. The alcohol formed by fermentation of the sugar may eventually stop the yeast activity; in grapes with but little sugar, it is all fermented and a **sour** or **dry** wine results; where there is an excess of sugar a **sweet** wine is formed. If wine is bottled before fermentation has ceased, carbonic acid is retained in the wine to form **sparkling** wine, as distinguished from **still** wine. As 10 to 12 per cent of alcohol stops fermentation, wine is usually **fortified** by adding grape brandy or alcohol. Finally wine is **clarified,** usually by precipitation methods using gypsum, gelatin, etc. It is especially desirable to remove all of the tannin. Pasteur introduced sterilization of certain wines as a preservative measure against acetic fermentation.

Wine is used medicinally as a mild stimulant and tonic.

Brandy is an alcoholic liquid obtained by the distillation of the fermented juice of sound ripe grapes and containing at 15.56° C. from 48 to 54 per cent, by volume, of C_2H_5OH. It must have been stored in wood containers for a period of not less than two years. Brandy meets the requirements of the tests of the National Formulary.

Brandy is used as a prompt stimulant in many forms of debility.

Argol or Crude Tartar is formed as a deposit in wine casks after the alcoholic fermentation of grape juice. It consists of potassium bitartrate with some cal-
cium tartrate, coloring matter and extr
in 165 parts of cool water and is nearly
tion in the wine casks. Argol from red
used almost exclusively for the preparation of **cream of tartar** and of tartaric **acid.**

MALVACEÆ, OR MALLOW FAMILY

This is a family of about 50 genera and 1000 species, widely distributed. The plants are mostly herbs, with simple leaves, regular flowers (having the stamens united into a column, which encloses the styles) and a capsular fruit. The mucilage secretory organs are characteristic: (A) epidermal cells in which the walls become metamor-
phosed to muc ... leaves in which
the walls unde ... mucilagi-
nous cavities ... d occur in
the pith and the cortex. In the roots of *Althæa* the walls of the parenchyma cells of the vascular bundles are likewise modified to mucilage. Secretory cavities of schizogenous origin, and containing a yellow or yellowish brown amorphous substance, are found in *Gossypium* and some other genera. Non-glandular hairs, usually stellate, and glandular hairs of various forms in the different genera are frequently present.

ALTHEA

Althea or Marsh Mallow Root (U. S. P. 1831 to 1947; N. F. 1947 to date) is the dried root of *Althæa officinalis* Linné, derived of the brown corky
layer and small roots. ... ...ing or cool-
ing, in reference to th ... erennial
herb with erect woolly stems attaining the height of ... meter,

indigenous to central Europe and has been naturalized in the United States, occurring in the marshes from Massachusetts to Pennsylvania.

The commercial supply is from Germany, France and Holland. The roots are collected in the autumn from plants of the second year's growth. Frequently the root is cut into small cubical pieces about 5 mm. in diameter, having a uniform grayish white color. Althea was described by Dioscorides. Charlemagne (742 to 814 A.D.) commanded that it be cultivated in his domain.

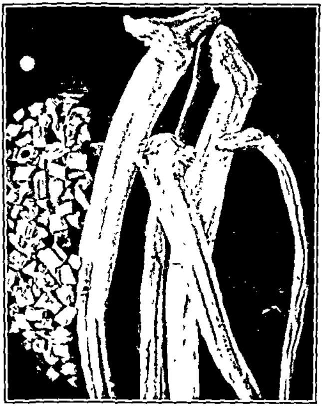


FIG. 226.—Commercial Althea Root. The whole peeled root and the cut root. (Photo by P. D. Carpenter.)

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 226, 227 and the National Formulary.

CONSTITUENTS.—Mucilage, 25 to 35 per cent, asparagin (amido-succinamide), 1 to 2 per cent, starch, about 35 per cent, pectin, about 10 per cent, sugar, about 10 per cent; ash, about 5 per cent.

Asparagin (β-asparagin, the monamide of aspartic acid) is an amido compound which is widely distributed throughout the vegetable kingdom. It is

rôle in plant metabolism. It forms crystals up to 0.5 mm. long from the expressed

juices or by mounting sections of them in glycerin. It has an acid reaction, is insoluble in alcohol, but soluble in 47 parts of water at 17.5° C. and in 1.9 parts of distilled water at 98° C. It occurs in two forms, which are dextrorotatory and levorotatory; the latter usually present in plants. Asparagin appears when proteins are being utilized by the plant, and also when they are being formed by the plant.

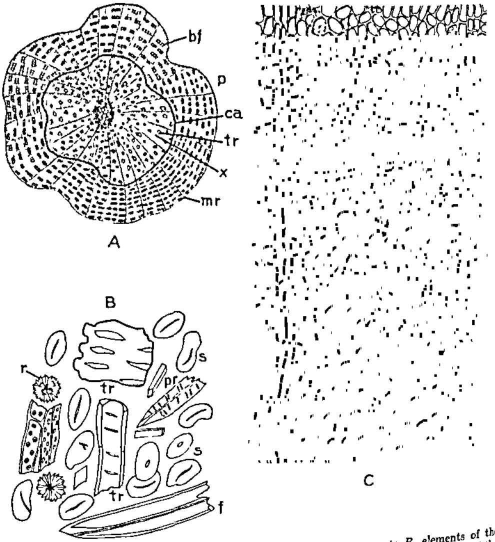


Fig. 227 —Althea. A Diagram of a cross-section of the root; B, elements of the ... transverse section of the ... s (bf) arranged in ... or crystal-bearing ... parenchyma; ca cambium, distinct ... xylem rays, composed mostly c... ut a few tracheæ (tr) with ... rains (s) ... g central numerous ellipsoidal or irregular, up to 30 microns long and irregular... cleft; bast fibers (bf and f) long, narrow, walls thickened, non-porous and more or less lignified; calcium oxalate crystals few, in prisms (pr) or rosettes (r) up to 35 microns in diameter. (Drawing by Edward Fried.)

Standards and Tests.—Althea contains not more than 1 per cent of foreign organic matter. When 1 gm. of comminuted althea is macerated in 10 cc of water for thirty minutes and then filtered through cotton, it yields a mucilage of pale yellow color which is neutral to litmus and which assumes a deep yellow

color when treated with sodium hydroxide T.S. This latter mixture does not have a sour or an ammoniacal odor.

sed

i to

1936) consists of the dried leaves of *Althæa officinalis*. They are broadly ovate, petiolate, 3 to 10 cm. broad, with acute apex, cordate base, dentate, somewhat lobed margin, and surfaces velvety pubescent; inodorous and mucilaginous.

The powdered drug is grayish green, with numerous non-lignified stellate hairs, in clusters and up to 600 microns long, calcium oxalate rosettes up to 30 microns in diameter, epidermal fragments with stomata up to 37 microns

vith highly

consists of

are rich in

mucilage, up to 16 per cent of the dry weight, and are used only for their demulcent and emollient properties.

Mallow Leaves or Malvæ Folia (N. F. 1916 to 1936) consists of the dried

contains up to 20 per cent of mucilage, 16 per cent of total ash, and about 0.3 per cent of acid insoluble ash. It is used as a demulcent and emollient.

The roots of a number of other genera of this family are used for similar

and *Ceiba*.

COTTON

Purified Cotton or Absorbent Cotton (U. S. P. 1851 to date) is the hair of the seed of cultivated varieties of *Gossypium hirsutum* Linné or of other species of *Gossypium*, freed from adhering impurities, deprived of fatty matter, bleached and sterilized. *Gossypium*, the ancient name for the cotton plant, is from the Arabic *gos* meaning a soft silky substance; *hirsutum* is from the Latin meaning rough or hairy.

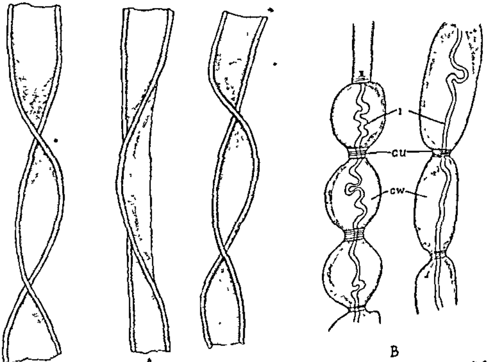
G. hirsutum, as cultivated in the southern United States, is an annual herb attaining a maximum height of about 4 feet, and yields most of the commercial cotton known as American Upland Cotton, *G. barbadense*, a somewhat larger plant, is cultivated in South Carolina and Georgia along the sea coast, and yields Sea Island Cotton.

The plants produce capsules (bolls) which open when ripe along longitudinal sutures, revealing a mass of white hairs attached to the brownish seed. The mass of hairs (cotton fibers) and seed is collected and "ginned," a machine process of removing the seed. To render cotton absorbent and suitable for surgical use, it is first carded (combed) to remove gross impurities and short hairs (linters), then washed with weak alkali solution to remove fatty materials, then bleached with chlorinated soda, washed with weak acid and then with water and finally

dried and recarded into flat sheets. After the absorbent cotton is packaged, it is usually sterilized.

Cotton for textiles is spun into thread and then woven, or it may be treated with various chemicals, when it yields such fabrics as mercerized cotton, rayons and others. The United States produces about half the supply of cotton of the world. Cotton is also produced in Egypt and other tropical parts of Africa, India, the West and East Indies and South America.

Cotton has been known since remotest antiquity. It has been cultivated in India for more than 3000 years. Egypt had a well developed cotton industry 4000 years ago. It has been found in the mounds of the Aztecs in Mexico, which probably antedate the pyramids of Egypt.



A B

... flattened, twisted hairs, *B*, the hairs after ... the reagent (*cu*); encir... ...brane lining of the cavity

DESCRIPTION.—A white, soft, tufted mass, consisting of somewhat flattened, twisted and spirally striate, 1-celled, non-glandular hairs, from 2.5 to 4.5 cm in length and 25 to ... and tasteless. ... vely of cellulose,

CONSTITUENTS.— ...
is soluble in ammo... n 0.2 per cent of

STANDARDS AND ... nd water-soluble ash and should be free from alkali, acid, fatty ... substances. Consult the U. S. Pharmacopœia for the methods of detecting these; also the tests for fiber length, sterility and absorbency.

... as a surgical dressing where ... ucus or pus, and to keep ... cotton is employed for

textiles and as a source of pure cellulose in the manufacture of explosives, celluloid, etc.

Adulterants.—Various substances may be added to absorbent cotton to increase the rate of absorption of water, as chlorides of calcium, magnesium

tinguished by having very thin walls and a thin outer layer of cutin. They lack the essential properties for technical uses.

Absorbent Gauze, Gauze, Plain Gauze or Non-sterilized Absorbent Gauze (U. S P. 1942 to date) consists of well-bleached cotton cloth of plain weave. It is white cotton cloth of various thread counts and weights The ash does not exceed 0 15 per cent of the weight of the gauze. The Pharmacopœial tests prohibit or greatly limit the presence of dyes, fatty matter, dextrin or starch, acid, alkali and water extract in the gauze Tests are provided for thread count, weight and absorbency of the gauze.

Sterile Absorbent Gauze, Gauze (U. S. P. 1942 to date) is absorbent gauze which has been rendered sterile and protected from contamination. The Pharmacopœia requires that each unit of sterile gauze be packed individually so that the sterility of the unit be maintained until the package is opened for use.

Adhesive Absorbent Gauze or Adhesive Gauze is an individual dressing prepared by affixing a plain absorbent compress to a strip of adhesive plaster It must be sterile and each unit protected from contamination by suitable packaging.

Carbolized Gauze (N F 1888 to 1906) is prepared by immersing loosely-folded pieces of gauze muslin in an alcoholic solution of resin, castor oil and phenol, and pressing out the gauze until its weight is 170 parts for every 100 parts of dry gauze Preserve in air-tight containers It contains when dry about 2.5 per cent of phenol.

Iodoform Gauze (N F. 1888 to 1906) is prepared by immersing a weighed

Gauze Bandage or Roller Gauze Bandage (U. S. P. 1942 to date) is prepared from Type I Absorbent Gauze in various widths and lengths Each bandage is in one continuous piece, tightly rolled and substantially free from loose threads and ravelings. Gauze bandage must be sterile and protected from contamination.

Cottonseed Oil (U. S. P. 1882 to date) is the refined fixed oil obtained from the seed of cultivated plants of various varieties of *Gossypium hirsutum* Linné or of other species of *Gossypium*. The cotton seed, after ginning off the fibers, is decorticated, cleaned of hulls, the kernels steamed and pressed at about 1500 pounds pressure to yield about 30 per cent of oil. The oil thus obtained is turbid and reddish in color; it is refined by filtering, decolorizing and "winter chilling" which removes the stearin.

Description.—Cottonseed oil is a pale yellow, oily liquid. It is odorless and has a bland taste. Consult the U. S. Pharmacopœia for characteristics and tests.

Constituents.—Cottonseed oil consists largely of olein with small quantities of palmitin and stearin or the corresponding fatty acids, which, however, are largely removed in well-purified oil.

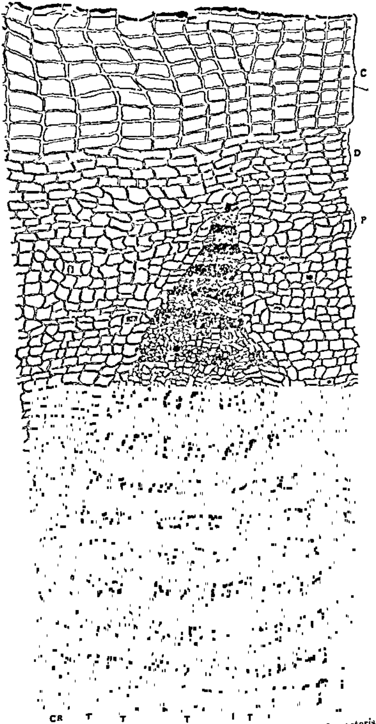


Fig. 229.—Transverse section of cotton root bark showing the characteristic cone-shaped strands of phloem; C, layers of cork consisting of rectangular tabular cells with ... ls of cortex, P, parenchyma of primary ... te rosettes (Cr); B, bast; Sc, secretory ... After Morgan.)

USES AND DOSE.—Cottonseed oil is a bland, nutritious oil and is used in liniments on account of its emollient properties The oil is employed in place
'ble quantity is hydrogenated
amount is also used in the
' cottonseed oil are produced

Cottonseed Cake contains about 0 6 per cent of a toxic principle, gossypiol, which occurs in secretory cavities in all parts of the plant It is present in cold pressed oil from which it may be removed by treatment with alkalis.

Cotton Root Bark (U. S. P 1863 to 1916, N. F. 1916 to date) is the recently gathered, air-dried bark of the root of one or more of the cultivated varieties of *Gossypium hirsutum* Linné, or of other species of *Gossypium*. Most of the commercial supplies come from Virginia, the Carolinas and other cotton growing states.

DESCRIPTION.—In flexible bands or in transversely curved or slightly quilled pieces, the bark 0 5 to 1 mm in thickness, outer surface light brown, longitudinally wrinkled, with small lenticels, periderm frequently exfoliated; inner surface light brown, longitudinally striate, fracture tough, fibrous, readily separable into fibrous layers

POWDER.—Light brown, odor faint; taste slightly acrid, bast fibers up to 1 mm. in length, about 15 microns in width, the walls strongly lignified and with very few pores,
somewhat spheroidal
parenchymatous cells
filled with starch; calcium oxalate crystals in rosettes from 10 to 25 microns in diameter

CONSTITUENTS —About 8 per cent of a peculiar, colorless acid resin, which is soluble in water and becomes reddish and insoluble on exposure to the air, hence, the drug, promptly after drying, should be prepared into fluidextract to preserve its activity It also contains fixed oil; tannin; starch and calcium oxalate Total ash, about 4.8 per cent.

USES AND DOSE —The drug is an emmenagogue and an oxytocic Average dose, 2 gm

The **flowers** of the cotton plant contain an interesting glucoside, gossypetin, which becomes green on oxidation and is colored orange red with solutions of alkalis It somewhat resembles a similar principle found in arbor vitæ (*Thuja occidentalis*).

STERCULIACEÆ, OR COLA FAMILY

This is a family of about 58 genera and 660 species of tropical and subtropical plants. They comprise a great many forms, some being lianes They resemble the *Malvaceæ* very closely and are distinguished by their 2-locular anthers. The mucilage secretory organs occur as mucilaginous membranes, as lysigenous mucilaginous cavities and as schizogenous or lysigenous canals. In addition, tannin-secretion cells are usually present. Non-glandular hairs, although usually stellate, peltate or tufted, may occur in other specific forms The glandular hairs are either unicellular or made up of a few cells, and somewhat resemble those of the *Malvaceæ*.

THEOBROMA

Cacao Seeds or Cacao Beans are the roasted seed of *Theobroma Cacao* Linné *Theobroma* from the Greek means "food of the gods," *cacao* is from the Aztec name of the tree; "chocolate" is from the Mexican, and it has long been highly

esteemed by the Aztecs and the Mexicans, and later by the Europeans who learned of it from them.

The plant is a tree attaining the height of about 12 meters and is indigenous to Mexico bu[illegible] the older bra[illegible] 10-furrowed [illegible] 10 or 12 in each row (Fig. 230). Cacao was known to Columbus and Cortez. Most of the cacao seed of the market is obtained from Ecuador (the Guayaquil variety being especially valuable), Curaçao, Mexico, Trinidad, Central America, Brazil, West Africa (Nigeria and the Gold Coast), Ceylon, Java and the Philippine Islands

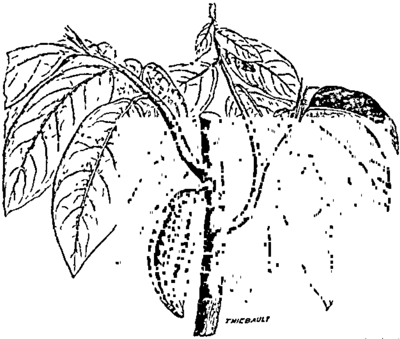


FIG 230 —Cacao tree (*Theobroma cacao*) showing the peculiar habit of the fruits in developing on the main axis as well as on the branches (After Baillon)

[illegible] changing during [illegible] roasted (not the [illegible] dor and taste abo[illegible] rack the seed The roasted seed are passed through a "nibbling mac[illegible] [illegible] from the kernels by winnowing The [illegible] ground between hot rollers they [illegible] it, **Cacao Butter.** The paste con[illegible] geals at room temperature to form **Bitter Chocolate. Sweet Chocolate** is bitter chocolate to which sugar and vanilla or other flavoring substances have been added. After expressing cacao butter, the marc, retaining some oil, is powdered and known as **Prepared Cacao, or Breakfast Cocoa.** Some brands of cocoa contain alkali to render it "soluble," it is, of course, not soluble, but the alkali partially saponifies the fat at the surface of each minute particle, resulting in a smoother and more complete suspension of the cocoa in the water or milk of the drink

Cacao Seeds or Cacao Beans are often found on the market as such The seed is irregularly ellipsoidal or ovoid, somewhat flattened, from 15 to 30 mm in length, externally reddish brown to dark brown; seed coat thin and shell-like, readil[illegible] the latter are very fleshy, much folded and [illegible] the hilum portion of the seed; odor

The seeds contain 35 to 50 per cent of a fixed oil, about 15 per cent of starch; 15 per cent of proteins; 1 to 4 per cent of theobromine; 0 07 to 0.36 per cent of caffeine; about 0 5 per cent of sugar, and a small amount of tannin The red color of the seed is due to a principle known as cacao-red, which is formed by the action of a ferment on a glucoside When the seeds are roasted the theobromine present in the kernel passes into the shell, the latter being the commercial source of the alkaloid

Theobromine is an alkaloid, 3, 7-dimethylxanthine ($C_7H_8O_2N_4$) obtained from cacao seed, or rather cacao shells after the roasting of the seeds It is also present in Kola nut.

The alkaloid is slightly soluble in cold water, 1 to 2000, or in alcohol 1 to 2200, but becomes readily soluble in water when combined with bases. Dose, 0 3 to 0.5 gm.

Theobromine and Sodium Salicylate (U. S. P. 1916 to 1942; N. F. 1942 to date) is a hydrated mixture of theobromine sodium and sodium salicylate in approximately molecular proportions When dried at 110° C., it yields not less than 46.5 per cent of anhydrous theobromine and not less than 35 per cent salicylic acid. It is a white, odorless powder having a sweetish, saline and somewhat alkaline taste. It is soluble in one part of water; if the mixture absorbs carbon dioxide with the liberation of theobromine, it becomes incompletely soluble in water. Average dose, 1 gm.

Theobromine and Sodium Acetate (U. S. P. 1942 to date) is a hydrated mixture of theobromine sodium and sodium acetate in approximately molecular proportions It contains not less than 55 per cent and not more than 65 per cent of anhydrous theobromine It is a white, crystalline powder, practically odorless, and of a bitter taste It is soluble in 1.5 parts of water and is alkaline in reactions Average dose, 0 5 gm.

Theobromine is a diuretic and myocardial stimulant; it has but little stimulant action on the central nervous system, hence is preferred over caffeine in cardiac edemas and to relieve the pain of angina pectoris.

Cacao Butter [illegible]
faint, agreeable [illegible]
30° and 35° C. [illegible]
oleic, and other [illegible]
gravity, 0.858 to 0 864 at 100°/25° C., refractive index, 1.4537 to 1.4578 at 40° C.; saponification value not less than 188° and not more than 195°; iodine value not less than 35 and not more than 40; the fatty acids solidify between 45° and 50° C. Cacao butter must be free from wax, stearin or tallow.

Cacao butter is used pharmaceutically almost entirely for making suppositories.

Cacao, Powdered Cocoa (N. F. 1916 to date) is a powder prepared from the roasted, cured kernels of the ripe seed of *Theobroma Cacao* Linné

[illegible]

butter in small prisms or needles. A few fragments of seed coat consisting of hexagonal epidermal cells and a peculiar mucilage layer of small tubular cells

and a layer of nearly isodiametric *stone cells about 10 microns in diameter may* be present.

STANDARDS AND TESTS.—Cacao yields not more than 22 per cent of non-volatile, ether-soluble extractive, which does not have a spicy odor or taste. *The ether-insoluble residue, dried to constant weight, yields not more than* 7 per cent of crude fiber, *not more than 8 per cent* of total ash, and not more than 0.4 per cent of acid-insoluble ash. *It shows*, microscopically, not more than 3 per cent of cacao shells and not more than 15 *per cent of starch.*

USES.—Cacao is a nervine and a stimulant; it is used chiefly in the form of a beverage and as a flavoring agent.

Cacao Shells are used as such, or admixed with cocoa, to form a cheap grade of cocoa. These may be detected when as low as 1 per cent are present by a fluorescence shown under the microfluoroscope. Cereal starches or starchy products have been used as an adulterant for cocoa, but rarely so now.

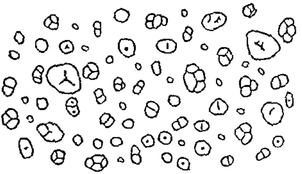


FIG. 23'.—Cacoa starch· starch grains of commercial cacao powder, or chocolate, after removal of the oil by means of ether.

KOLA

Kola, Cola or Kolanuts (N. F. 1916 to date) is the dried cotyledon of *Cola nitida* (Ventenat) Schott and Endlicher, or of other species of *Cola*. It yields not less than 1 per cent of anhydrous caffeine. The African name of the drug is Cola. The plant is a large tree *indigenous* to West Africa between Sierra Leone and the Congo It is now cultivated in East Africa, Ceylon, Java, Brazil and the West Indies. The fruit is a pod 5 or 6 inches long, which slowly dehisces, when the seeds are carefully collected, dried and packed. The commercial supplies come principally from western *Africa* and the West *Indies*, the latter being known commercially as **Bichy** or **Bissy-bissy Nut.**

DESCRIPTION.—Cotyledons, irregularly plano-convex or polygonal, 2 to 5 cm in length, brown, nearly smooth, heavy, hard and tough, *the edges slightly* recurved and sharp.

POWDER.—Light brown to moderate yellowish brown; odor characteristic; ... numerous, up to 45 microns in ... *with a central hilum or* ... arenchyma cells mostly

... omine, less than 1 per ... annin; *total ash*, about ... with a *tannin-like* sub- ... ied the caffeine assumes

its activity.

also a tonic and an astringent. Average dose, 4 gm.

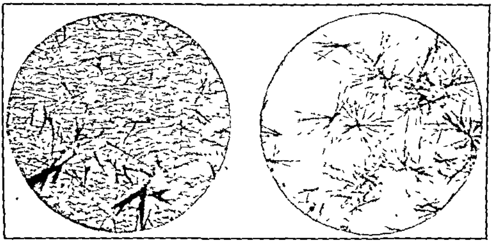


Fig 232 Fig 233

Fig 232 —The sublimate of caffeine from powdered kola

Fig. 233 —Crystals of caffeine-gold-chloride obtained by treating the sublimate with 5 per cent gold chloride solution (Photomicrographs by Adamson)

Allied Products —The seeds of a number of other plants are said to be sometimes admixed with kola and of these the following may be mentioned: *Cola ballayi*, a plant growing in the Gaboon, the seeds of which contain 6 cotyledons and are deficient in alkaloids The seeds of *Garcinia cola* (Fam *Guttiferæ*) have been substituted for kola under the name of "Staminate Cola" These seeds do not contain caffeine, but contain two resins which seem to have a

CAFFEINE

Caffeine (U. S. P. 1882 to date), 1, 3, 7-trimethylxanthine, $C_8H_{10}O_2N_4.H_2O$ occurs in coffee, tea, cacao, guarana and maté as well as in kola. While caffeine can be produced synthetically, it is usually prepared from tea, tea dust or tea sweepings, or recovered from coffee roasters. Caffeine is anhydrous, or contains not more than 8 per cent of water of hydration.

Description. Caffeine occurs in white, flexible, silky, acicular crystals, usually matted together in fleecy masses and having a bitter taste Caffeine may be sublimed without decomposition on heating On treating a small quantity of caffeine with a few drops of nitric acid or chlorine water and evaporating the solution to dryness on a w

by ammonia. A similar

hydrochloric acid and a c

and adding a drop of ammonia water to the residue; or exposing to ammonia vapors; this is known as the **murexide reaction.** Caffeine may be identified microchemically by adding a drop of hydrochloric acid and a drop of 5 per cent solution of gold chloride. The resulting crystals are needles which occur in
Caffeine
Consult

USES AND DOSE.—Caffeine is a nervine and stimulant. Average dose, 0.2 gm.

Citrated Caffeine (U. S. P. 1894 to date) is a mixture in about equal proportions of caffeine with citric acid. Average dose, 0.3 gm.

Caffeine and Sodium Benzoate or Caffeine Sodio-benzoate (N. F. 1888 to 1916; U. S. P. 1916 to date) is a mixture of caffeine and sodium benzoate, which contains, when dried at 80° C. to constant weight, not less than 47 per cent and not more than 50 per cent of anhydrous caffeine, and not less than 50 per cent and not more than 53 per cent of sodium benzoate. The sum of the percentages is not less than 98 per cent and not more than 102 per cent. Average dose, 0.5 gm.

Caffeine and Sodium Salicylate or Caffeine Sodio-salicylate (N. F. 1888 to date) is a mixture of caffeine and sodium salicylate. When dried to constant weight at 80° C., it contains, in each 100 gm., not less than 48 gm. and not more than 52 gm. of caffeine, or of sodium salicylate. Average dose, 0.2 gm.

The solubility in water of caffeine is markedly increased by the presence of citric acid, benzoates, salicylates and bromides; caffeine and sodium benzoate is most suitable for hypodermic or intramuscular injection.

STERCULIA GUM

Sterculia Gum or Gum Karaya (N. F. 1947 to date) is the dried gummy exudation from *Sterculia urens* Roxburgh, *Sterculia villosa* Roxburgh, *Sterculia tragacantha* Lindley or other species of *Sterculia*, or from *Cochlospermum gossypium* DeCandolle or other species of *Cochlospermum* (Fam. *Bixaceæ*). These trees are native to India and are widely scattered in the Indian forests. They may attain a height of 10 meters, but the trunks are very large, soft and corky. Sterculia is from the Latin *Sterculius*, the deity that presided over manuring in reference to the fetid odor of the trees.

The gum exudes naturally or from incisions made to the heartwood, and is collected throughout the year, except in the rainy season, but mostly from March to June. The incisions produce knob-like masses of gum, which should be frequently collected for nine months, then the tree should rest for two or three years. Grading and shipping is done in Bombay.

DESCRIPTION.—Sterculia gum occurs in tears or irregular fragments with a pinkish brown, translucent and
r and is insoluble in alcohol
be *few*. For constants and
llary.
ss than 50 cc. of water; the
blue color is produced with

iodine solution; foreign matter and bark does not exceed 3 per cent; the mucilage is more viscid but less adhesive than a corresponding mucilage of tragacanth.

USES —Sterculia gum is a mechanical laxative and is used for emulsions and suspensions; it has a large use in finger-wave sets and in skin lotions, also in the textile and printing industries; in the preparation of food products; in the preparation of composite building materials, etc.

THEACEÆ, OR TEA FAMILY

The plants of this family numbering about 16 genera and 175 species are shrubs or trees with alternate, evergreen leaves and perfect regular flowers with numerous stamens, occurring one or more in the axils of the leaves. The fruit is a 3- to 5-locular dehiscent capsule. The most important member of the family is *Thea sinensis*, the two varieties *viridis* and *bohea* furnishing the leaves known as tea.

Thea or Tea consists of the prepared leaves and leaf-buds of *Thea sinensis*, a shrub or tree with alternate, evergreen leaves The tea tree is indigneous to eastern Asia, and is now extensively cultivated in China, Japan, India and Java. The generic name is from the Greek meaning *goddess*, *sinensis* refers to its Chinese origin

Green Tea is prepared in China and Japan by rapidly drying the freshly picked leaves in copper pans over a mild artificial heat. Often the leaves are rolled by the palm of the hand as they dry.

Black Tea is prepared in Ceylon and elsewhere by heaping the fresh leaves until fermentation has begun, then rapidly drying with artificial heat and mechanical means

Tea occurs in more or less crumpled masses; bright green or blackish green; odor agreeable, aromatic, taste pleasantly astringent and bitter

Tea leaves are distinguished from most other leaves by their large colorless stone cells or idioblasts, which frequently extend from the upper to the lower surfaces of the leaf. For the structure and powder, see Figure 234 Adulterants are chiefly distinguished by possessing other forms of calcium oxalate crystals and hairs

Tea contains two alkaloids, caffeine (theine) 1 to 4 per cent, and theophylline in very small percentage, about 15 per cent of gallotannic acid; and about 0 75 per cent of a yellow volatile oil, solid at ordinary temperatures and having a strongly aromatic odor and taste Total ash about 2 5 per cent.

Tea is an astringent, it is also a nervine and a stimulant. It is used mainly in infusion as a beverage

Theophylline, Theocin or 1, 3-dimethylxanthine (U S. P. 1916 to date) is isomeric with theobromine, and was first isolated from tea in 1885. It is prepared synthetically from caffeine or by other means It occurs as a white, odorless, bitter crystalline powder and is soluble in about 120 parts of water.

Theophylline Ethylenediamine or Aminophylline (U. S. P 1936 to date) is a compound containing approximately 79 per cent of anhydrous theophylline and 13 per cent of ethylenediamine. It occurs as white or slightly yellowish granules or powder, with a slight ammoniacal odor and a bitter taste. It is soluble in about 5 parts of water, the solution being alkaline to litmus paper

Theophylline and Sodium Acetate (U. S. P. 1936 to date) is a hydrated mixture of theophylline sodium and sodium acetate in approximately molecular proportions. It yields not less than 55 per cent and not more

than 65 per cent of anhydrous theophylline. It is soluble in about 25 parts of water, the solution being alkaline to phenolphthalein T.S.

The three items above may be used as stimulants like caffeine, but are used principally as diuretics. The mixtures of theophylline with alkaline materials render the alkaloid much more soluble in water, hence more suitable for hypodermic use. Average dose of each is 0.2 gm.

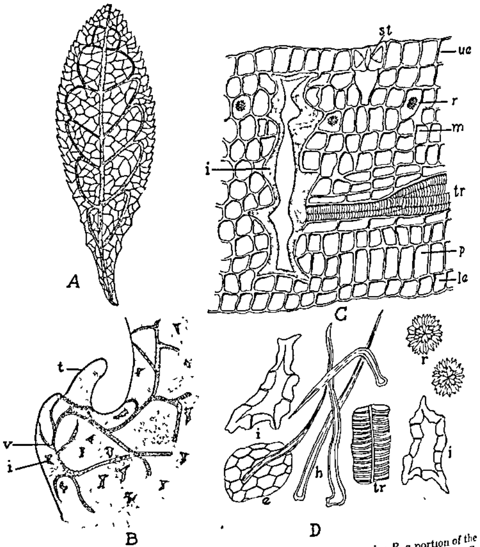


FIG 234 —Tea Leaves A, entire leaf showing venation and margin; B, a portion of the leaf cleared in chloral T S showing marginal tooth (t), veins (v) and idioblasts (i), C, transverse section through the blade of the leaf showing upper epidermis (ue) with stoma (st) mesophyll (m) containing rosettes of calcium oxalate (r), an occasional large elongated ... (i) and palisade (p), portion ... ments from powdered tea ... th, idioblasts (i), rosettes ... and a fragment

Maté or Paraguay Tea consists of the leaves of *Ilex paraguariensis* (Fam *Aquifoliaceæ*), is di ... stomata which are much larger than the epidermal cells ... ring near the veins are in nearly ...

fibers are associated with the tracheæ and calcium oxalate occurs in rosettes. Maté contains caffeine up to 2 per cent, volatile oil, tannin and matéviridic acid. It is laxative or purgative in large doses, stimulant, diaphoretic and diuretic. It is employed in South America in an infusion similar to tea, and is used to a considerable extent in a similar manner in the United States.

GUTTIFERÆ, OR GAMBOGE FAMILY

This is a family of about 45 genera and 900 species of tropical trees and shrubs. They all possess schizogenous resin canals in both the pith and the cortex. Resin cavities are also found in the leaves of certain genera. Lysigenous mucilage receptacles are present in *Quinia*. The tracheæ are marked by simple pores, the wood fibers may possess either simple or bordered pores; and wood parenchyma occurs in rather broad strands in the xylem. Calcium oxalate is usually secreted in the form of solitary crystals or rosettes, occasionally it occurs in small prismatic crystals, as in *Garcinia*. The stomata are especially characterized by having the neighboring cells parallel to the pore. Non-glandular hairs are either unicellular or uniseriate. Glandular hairs are wanting.

GAMBOGE

Gamboge (U. S. P. 1820 to 1936; N. F. 1936 to date) is the gum resin obtained from *Garcinia Hanburyi* Hooker filius. *Garcinia* is in honor of Laurent Garcin, a French botanist, and *Hanburyi* in honor of the English botanist, Hanbury. The tree attains a height of 15 meters in Cambodia, Siam and Cochin China, its habitat. Spiral incisions through the bark from the ground upward permit the resinous emulsion in the cortex and phlœm to exude. It is collected in bamboo nodes, and when solidified these are cracked open and the gamboge thus obtained is called Pipe Gamboge, the best commercial variety. That which hardens on the ground or is collected in leaves, known as Cake Gamboge, is more contaminated with dirt. The early Chinese regarded the drug as a poison and it was employed by them chiefly as a pigment. Its use as a purgative dates back to about 1600 A. D.

Description.—In cylindrical pieces, frequently hollow in the center, of variable length, 2 to 5 cm. in diameter, externally grayish orange brown, longitudinally striate, hard and brittle, the fractured surface somewhat conchoidal, orange red, waxy and somewhat porous.

Powder.— [illegible]
mounted in [illegible]
few fragmen[illegible]
solutions of [illegible]
soluble in alcohol [illegible]

Constituents.—Gum, allied to arabin, 15 to 20 per cent, a resin containing α-, β- and γ-garcinolic acids, known as cambogic acid, from 65 to 75 per cent; a volatile oil. Ash, 1 to 3 per cent with about 0.25 per cent acid-insoluble ash.

Standards and Tests.—Gamboge contains not more than 1 per cent of foreign organic matter and yields not more than 1 per cent of acid-insoluble ash and not less than 65 per cent of alcohol-soluble extractive. When rubbed with

water, gamboge yields a yellow emulsion which becomes darker and almost transparent upon the addition of ammonia water. The emulsion does not turn green upon the addition of iodine test solution.

Uses and Dose.—Gamboge is a drastic purgative or hydrogogue cathartic

Allied Products.—A drastic gum-resin is also obtained from *Garcinia morella* and other members of the *Guttiferæ* of India and Malaya, as *G collina*, of New Caledonia; *Vismia laccifera*, of Brazil; *Clusia rosea*, of the West Indies and South America, and *Clusia macrocarpa*, of Guiana. Gamboge of a poor quality is obtained from *Arasina gurgi*, of India.

CISTACEÆ, OR ROCKROSE FAMILY

This is a family of low shrubs and herbs of which there are about 150 species. They are found chiefly in the northern countries of both hemispheres. They possess simple leaves, regular and perfect flowers and capsular fruits, and are especially characterized by their thick-walled unicellular hairs, which are frequently united, forming stellate groups. The glandular hairs are always uniseriate. The pericycle is a continuous ring including both stone cells and bast fibers. Calcium oxalate is secreted in the form of rosettes.

Helianthemum. Frostweed or Frost-wort (U. S. P. 1851 to 1882; N. F. 1916

nic
co-
is

is used as a tonic, an astringent and an alterative.

BIXACEÆ, OR ANNATTO FAMILY

These are shrubs or trees found in the tropics and are of interest chiefly on account of the seeds of *Bixa orellana*, which furnish the coloring matter known as **Annatto (Orlean, Arnotta)**. The plant is found in tropical America and also in Polynesia and Madagascar. The seeds are covered with a fleshy arillus from which the coloring matter is prepared by means of water. The insoluble matter is collected, made into cakes and chiefly used for dyeing and coloring. Annatto contains a red crystalline principle, bixin, a yellow coloring principle, orellin and an ethereal oil. The root of this plant also contains some coloring matter.

FLACOURTIACEÆ

These are shrubs or small trees of tropical Africa and Asia, closely related to the Annatto family. There are about 70 genera and 500 species. Leaves simple, alternate, toothed or crenate; flowers in small racemes or panicles, diœcious, rarely showy; fruit a several-seeded berry, often edible.

CHAULMOOGRA

Hydnocarpus ioogra is the confused, as ii is in honor The plants old-pressed" of export.

Chaulmoogra Oil (U. S. P. 1826 to 1947; N. F. 1947 to date) is the fixed oil expressed from chaulmoogra seed. The fixed oil expressed from other species of *Hydnocarpus* when designated as such, and when conforming with the description, physical properties and tests for identity and purity prescribed by the National Formulary may be used.

Taraktogenos seed are irregularly ovoid, up to 2.5 cm. long, about one-half as thick; with a rather thin gray-brown testa, easily broken in commercial handling. The kernels yield up to 30 per cent of a fixed oil by expression. Hydnocarpus seed are about one-half as long and bear slight ridges radiating from the base. Their testa is thicker and not easily broken in commerce, hence the kernels are not so liable to deterioration. Hydnocarpus seed have been used medicinally in China and southeastern Asia for centuries.

The oil is a yellow or brownish yellow liquid, or at lower temperatures a soft, whitish mass, with a characteristic odor and somewhat acrid taste; it is sparingly soluble in alcohol but soluble in other fat solvents. Consult the National Formulary for its properties and constants.

…d, optically these acids

for *Bacillus Lepræ* and *Bacillus Tuberculosis in vitro*, ten times as powerful as that of phenol. However, in the treatment of clinical leprosy and of clinical tuberculosis with

salt and the ester are less irritant. Average dose, 1 cc.

Ethyl Chaulmoograte (U. S. P. 1926 to 1947, N. F. 1947 to date) consists of the ethyl esters of the mixed acids of chaulmoogra oil. It has the advantage over the oil of being less objectionable to the taste when taken orally, and less irritating locally when injected. Average dose, 1 cc.

CANELLACEÆ, OR CANELLA FAMILY

This is a small family of 4 genera, comprising in all about 8 species. They are mostly tropical or subtropical trees, having alternate evergreen leaves, golden yellow flowers and fleshy, berry-like fruits. The phelloderm is characteristic in that the inner walls of the cells are strongly

lignified. The pericycle does not contain any sclerenchymatous tissue. Secretory cells, distributed throughout the parenchyma of stems, roots and leaves are spheroidal or ellipsoidal, possess suberized walls and contain a yellowish oily content. Both glandular and non-glandular hairs apparently are wanting.

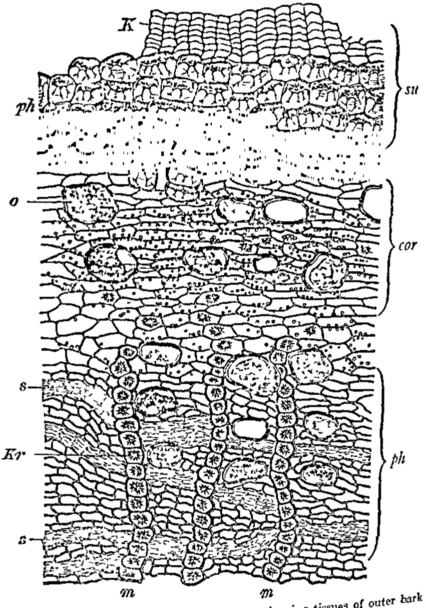


FIG. 235.—Canella Transverse section of bark, showing tissues of outer bark (*su*), middle bark or cortical region (*cor*), and inner bark (*ph*) *K*, cork cells, *ph*, inner layer of periderm, the stone cells 40 to 90 microns in diameter with strongly thickened, distinctly lamellated, porous and lignified inner walls, *o*, large oil cells with yellowish content, scattered in starch-bearing parenchyma, the starch mostly single grains, 5 to 20 microns in diameter, *s*, collapsed cells of sieve, *m*, medullary rays mostly one cell wide, each cell with a rosette of calcium oxalate (*Kr*) up to 50 microns in diameter. (After Tschirch.)

Canella, Canella Bark or White Cinnamon (U. S. P 1820 to 1882; N. F. 1916 to 1936) is the bark of *Canella alba*, a small evergreen tree indigenous to the West Indies and Florida. When bark is collected the light grayish cork is removed, the periderm of stone cells remaining. Bark in quills or curved pieces;

from 1.5 to 5 mm. in thickness; light yellowish brown to orange brown; somewhat scaly, reticulately wrinkled and fissured; fracture short, granular, with numerous secretion cells and wavy medullary rays, odor cinnamon-like; taste

tile oil
cent,

Canella is an aromatic and is used as a stimulant. It is also a condiment.
The barks of one or more species of *Cinnamodendron* of tropical America are
are distinguished by containing

. (U. S. P. 1820 to 1882, N. F. 1888 to 1936) is a mixture of Aloes, 4 parts, and Canella, 1 part, reduced to a fine powder. The carminative action of the canella modifies the purgative action of the aloes

TURNERACEÆ, OR DAMIANA FAMILY

This is a small family of tropical plants, of which there are about 6 genera and 100 species, distinguished among other characteristics by the fact that they contain tannin cells in the primary cortex, which are frequently developed in the form of idioblasts In the pericycle occur isolated groups of bast fibers Glandular and non-glandular hairs of a number of types are developed. Large nectarial glands occur on the margin and base of the leaves of *Turnera* and other genera.

Damiana or Turnera (N. F 1916 to 1942) is the dried leaf of *Turnera diffusa* or of *Turnera aphrodisiaca* The plant is a shrub growing in Brazil, Bolivia, Mexico, the West Indies and California. Most of the commercial supply comes from La Paz, Bolivia

DESCRIPTION AND STRUCTURE —See Figure 236 and the National Formulary Seventh Edition

of 30 microns, the stoma cells usually containing green plastids; numerous

principle, a hard brown resin, a mixture of soft resin and chlorophyll; tannic acid, a gummy substance, and protein substances, nearly 15 per cent Total ash, about 7.5 per cent, acid-insoluble ash, about 2 per cent.

Damiana contains not more than 15 per cent of the stems of the plant and yields not more than 4 per cent of acid-insoluble ash

The drug is a stimulant and a laxative, with some reputation as an aphrodisiac Average dose, 2 gm

VIOLACEÆ, OR VIOLET FAMILY

Viola or Violet (U S P 1820 to 1882) is the dried flowering plant of *Viola pedata* Linné. Bird's-foot Violet is indigenous in eastern United States west to

the Mississippi River. It is an herbaceous perennial up to 30 cm. high with a short thick rhizome, single flowers on scapes and radical, deeply cut leaves.

Viola Tricolor or Pansy (U. S. P. 1882 to 1894) is the wild-grown flowering herb of *Viola tricolor* Linné. Violet plants contain an alkaloid with a mild action like that of emetine causing nausea, purging and prostration in dogs. The drug, especially in Europe (*Viola odorata*), has long had repute as a remedy in infantile convulsions, dysentery, catarrhs and in cutaneous diseases.

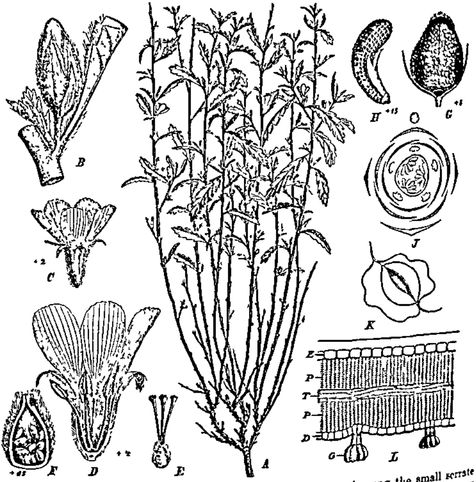


FIG. 236.—*Turnera aphrodisiaca.* *A*, portion of the plant showing the small serrate leaves. *B*, Portion of twig showing the flower bud. *C* and *D*, The flowers, the latter being in longitudinal section. *E*, Ovary with three long styles. *F*, Longitudinal section through the ovary showing a number of the ovules. *G*, The mature ovoid fruit. *H*, A cresent-shaped, reticulate seed, having a small, thin, membranous arillus. *K*, Stoma with subsidiary cells parallel to the pore. *L*, Transverse section through the leaf, showing upper epidermis (*e*), lower epidermis (*d*) with 2 glandular hairs (*g*); palisade cells (*P*); and tracheæ (*T*). *J*, Diagrammatic section of a flower of *T. ulmifolia.* (*B* and *J* after Urban; the remainder after Gilg.)

PASSIFLORACEÆ, OR PASSION FLOWER FAMILY

The plants of this family are mostly herbaceous or woody vines, and represented by about 18 genera and 325 species. They are most abundant in South America, a few of the species of *Passiflora*, however, being quite common in the southern United States. Nearly all of the plants have elongated tannin sacs and intercellular secretory canals.

with a brownish content. Non-glandular hairs are either unicellular or uniseriate, the former usually having a more or less hooked summit. Glandular hairs are usually of a woolly or shaggy type. Large nectarial glands are common to a number of the species. In the leaves, the epidermal layer is frequently modified to mucilage and occasionally is papillose; the cells of the mesophyll may contain spicular cells or crystal idioblasts.

Passiflora, Wild Passion Flower or Passion Vine (N. F. 1916 to 1936) is the dried flowering and fruiting top of *Passiflora incarnata*, a perennial climbing

Leaves more or less broken, when entire, 3- to 5-cleft, long petiolate, the lobes lanceolate-ovate, apex acute, margin serrate; light greenish brown to dark
nt.
als
sh
a
yellowish white color, stamens 5, monadelphous; ovary superior, unilocular, becoming in fruit a berry, from 4 to 5 cm. in length, having 3 to 4 parietal placentæ, and numerous ovoid, flattened seeds having a yellowish or brown ari

are
6 mm in diameter, light yellowish brown and finely striate The leaves alone are sometimes collected, and a preparation is sometimes made from the freshly expressed juice of the plant

CARICACEÆ, OR PAPAW FAMILY

This is a family composed of 2 genera of latex-containing trees, growing in tropical America, the best known of which is the genus *Carica*. The latex occurs as a finely granular protoplasm-like substance, which contains the peptonizing ferment papain, in articulated laticiferous tubes, which occur in the pith, cortex and xylem of roots and stems and are associated with the vascular bundles in leaves, even penetrating into the mesophyll The pericycle is composed of isolated groups of bast fibers. The tracheæ are marked by simple pores or reticulate and scalariform thickenings. The medullary rays and wood fibers are apparently replaced with parenchyma.

PAPAIN

Papain (N. F. 1947 to date) is the dried and purified latex of the fruit of *Carica Papaya* Linné. Papain possesses a digestive activity not less than that of Reference Papain. The tree is indigenous to tropical America and is cultivated in Ceylon, Tanganyika, Hawaii, Cuba,

Florida and other parts of tropical America. It is up to 5 meters in height and about 15 cm. in diameter. It has an active life of about five years. The pistillate flowers are about 2.5 cm. in length, 1 to 3 in short-stalked cymes, at the base of the leaf stalks. The fruit, in the tropics, may attain a length of 30 cm. and a weight of 5 kg. The epicarp adheres to the orange colored, fleshy sarcocarp which surrounds the central cavity containing a mass of nearly black seeds.

The full-grown, unripe fruit receives shallow incisions once a week on four sides of the fruit. The latex flows freely for a few seconds and then stops, after which it is collected and soon coagulates into lumps. Collections are made between 5 and 10 A.M. The lumps are shredded and dried in the sun or by means of artificial heat, the latter method yielding the better grade of crude papain. It is purified by dissolving in water and precipitating with alcohol.

Description and Assay.—See the National Formulary.

Constituents.—Papain contains several enzymes: one or more proteolytic enzymes; a coagulating rennet-like enzyme which acts upon the casein of milk; an amylolytic enzyme; a clotting enzyme similar to pectase; and an enzyme having a feeble action on fats. It is quite apparent that more than one proteolytic enzyme is present, because a single sample of papain will yield variable results depending upon the protein used in the substrate. The best grade will digest 300 times its weight of egg albumen.

Uses.—Papain is used as a digestant for proteins, having an action similar to pepsin. In the meat packing industry it is extensively used for tenderizing ham.

CACTACEÆ, OR CACTUS FAMILY

This is a remarkable family of about 1500 species of succulent plants, growing largely in the arid regions of Mexico, Brazil and other parts of America. They usually possess thick, fleshy stems, the structure of which is adapted to a desert climate, the foliage leaves being modified to thorns. Mucilage cells and lysigenous canals are common to all of the plants of this family. In addition there are crystal cells and laticiferous canals. Calcium oxalate is excreted in enormous quantities, sometimes being present to the extent of 85 per cent of the ash of the plant. It occurs in the form of large rosettes, raphides, octahedra, tetragonal and monoclinic prisms. Sometimes they occur as sphæro-crystals and may resemble half-compound starch grains in the arrangement of their needle-like crystals. Occasionally the crystals are contained in idioblasts. In alcoholic material sphæro-aggregates may crystallize out in some of the cells. In *Epiphyllum*, curiously shaped protein bodies are distributed. The guard cells of the stomata are accompanied on both sides by one or more subsidiary cells parallel to the pore. The thorns are variously interpreted as being foliar organs, emergencies, i. e., multicellular hairs derived from both the epidermal and hypodermal layers, or transitions between leaf-prickles and trichome-prickles. The tracheæ possess either simple pores or spiral thickenings; the wood fibers usually have simple pores; and the medullary ray cells may become lignified. In addition, tracheid-like parenchymatous cells are found in the wood of *Opuntia* and other genera.

Cactus Grandiflorus or Night-blooming Cereus (N. F. 1916 to 1947) is the fresh succulent stem of the wild-growing *Selenicereus grandiflorus* (Linné) Britton et Rose. The plant is a perennial with thick succulent stems and large fragrant flowers, expanding only at night and lasting but a few hours. It is

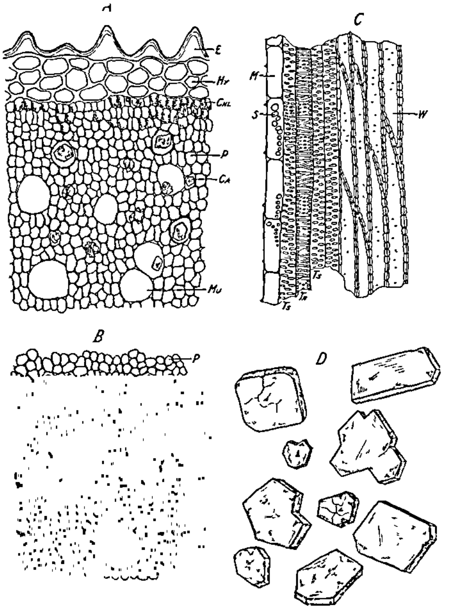


Fig. 237. Cactus Grandiflorus. *A*, section of stem. *E*, papillose epidermis, *Hy*, hypodermis, *P*, cortical parenchyma containing chloroplasts (*Chl*), *Ca*, solitary crystals of calcium oxalate up to 100 microns in length, *Mu*, mucilage cells. *B*. Transverse section of the fibrovascular bundles. *Bf*, bast fibers, *M*, broad medullary rays, the cells containing

indigenous only to the *West Indies, though it is* extensively cultivated as a house plant. Commercial supplies have come largely from Mexico, collected from a variety of cactus *plants, and without* therapeutic value. The drug is shipped preserved in alcohol which is then used *to extract it.*

The drug consists of cylindrical, *five- to nine-angled*, branching, stems; 1 to 4.5 cm. in thickness; externally bright green and with alternate clusters of

The drug contains a glucoside, one or more resinous substances, and possibly an alkaloid.

Cactus Grandiflorus has been used as a substitute for digitalis. Only the best West Indian drug should be employed. Average dose, 0.5 gm.

Mescal Buttons or Anhalonium are the dried tops of several species of Lopho-
ant is under ground,
r less button-shaped
e center of the disk
The drug contains
the symptoms of mescal
ic. Alkaloidal principles

THYMELEACEÆ, OR MEZEREON FAMILY

This is a family of about 40 genera and 500 species of shrubs and trees, most abundant in Australia and South Africa, a few of the genera, however, being found in the United States. The plants have simple, deciduous or evergreen leaves and small, mostly perfect flowers; and the fruits are usually berry-like drupes. Calcium oxalate is secreted in many forms. The plants possess no internal secretory cells or glandular hairs. The non-glandular hairs are usually unicellular. In the leaves there is mucilaginous metamorphosis of the epidermal cells, the latter often becoming papillose. The stomata usually occur only upon the upper or ventral surface of the leaf and are frequently enclosed in receptacles formed by the papillose elevations of the neighboring cells.

MEZEREUM

Mezereum or Mezereon (U. S. P. 1820 to 1926; N. F. 1926 to date) is the dried bark of *Daphne Mezereum* Linné, of *Daphne Gnidium* Linné, or of *Daphne Laureola* Linné. Daphne was a Greek nymph who was transformed into a laurel bush while fleeing from Apollo; *Gnidium* is an ancient name for laurel: *Laureola* means *laurel-like*, *mezereum* is from *mazariyum*, the Persian name of the plant. The plant is a slow growing deciduous shrub. The bark is collected in early the commercial
e and Algeria
eems to have
thority.
entered American practice through traditional English authority.

Description.—In flexible, tough quills or somewhat flattened strips; bark from 0.3 to 1 mm. in thickness, outer surface olive-brown, purplish brown or purplish gray, smooth, numerous lenticels, giving a transversely striated appear-

ance and occasionally with numerous circular brownish black apothecia; inner surface pale yellow, satiny lustrous, finely striate, fracture tough, fibrous, the inner bark lamellated.

STRUCTURE.—Cork 20 to 40 rows, the outer compressed, the inner with tabular cells with nearly colorless walls; a hypodermis of 3 to 5 rows of collenchyma containing chloroplastis or a greenish yellow resinous substance, inner bark of loosely united groups of colorless bast fibers and sieve strands, medullary rays few, uniseriate.

POWDER.—Light brown; odor slight; sternutatory; taste slowly developing to strongly pungent and acrid; bast fibers up to 3 mm. in length and about 15 microns wide, more or less uneven or irregularly bent and attenuated at the ends, the walls colorless, non-lignified and free from pores; fragments of yellowish brown cork, and of medullary rays containing starch; starch grains relatively few, mostly spheroidal or ellipsoidal, and varying from 3 to 15 microns in diameter.

CONSTITUENTS.—An acrid resin known as mezerein, a crystalline, bitter

sialagogue and a stimulant Average dose, 1 gm.

The berry-like fruits of *Daphne Mezereum* and *D. Gnidium* are subglobular, dark brown or brownish black, about 5 mm. in diameter, each with a black

PUNICACEÆ, OR POMEGRANATE FAMILY

This is a small family represented by a single genus, *Punica*, of which there are two species. In the pericycle there are isolated groups of bast fibers, beneath which the cork develops In the primary cortex occur large stone cells, either single or in small groups The fibrovascular bundles are bi-collateral; bast fibers are wanting in the cortex; the tracheæ and wood fibers possess simple pores; and calcium oxalate is excreted in the form of rosettes.

GRANATUM

Pomegranate Fruit or Granatum (U. S. P. 1820 to 1842)
Pomegranate Fruit Rind or Granati Fructus Cortex (U. S. P. 1842 to 1882).
Pomegranate Bark or Granati Cortex (U S. P. 1831 to 1842)
Pomegranate Root Bark or Granati Radicis Cortex (U. S. P. 1842 to 1882).
Pomegranate Root and Stem Bark or Granatum (U S. P. 1882 to 1936).
Pelletierine Tannate (U S P. 1905 to 1947; N F. 1947 to date).

All are derived from *Punica granatum* Linné, a shrub indigenous to northwestern India and cultivated in subtropical regions throughout the world for its edible fruit All parts of the plant contain tannin (a mixture of two or more

kinds); pomegranate rind, up to 28 per cent of tannin; the dried root bark, up to 22 per cent; hence these are very astringent drugs. *The pulp of the fruit is used medicinally* as an acidulous *refrigerant*. The stem and root barks have long been used as an anthelmintic and tænifuge; Dioscorides mentions a decoction of the [illegible]

[illegible] was found to be a mixture of four alkaloids.

The dried fruit rind occurs in irregularly curved, yellowish brown fragments about 2 mm. in thickness. It assumes a bluish black color with ferric salts.

The dried scraped root bark is dark brown, with patches and scales of cork, no green phelloderm layer, and medullary rays extending nearly to the outer surface. The yield of pelletierine may be as high as 3 per cent. [illegible]

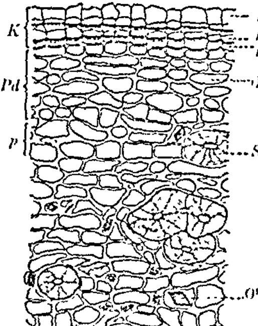


FIG. 238.—Transverse section of Granatum. *K*, *corky layer* composed of thin-walled cork cells (k^1) and *thick-walled* cork cells (k), only the inner walls (i) of which are thickened. *Pd*, phelloderm cells, *pr*, a few parenchyma cells of the *primary cortex*; *Sk*, stone cells with thick, lamellated walls and fine, branching *pores*. *O*, rosettes of calcium oxalate, O^1, monoclinic *prisms* of calcium oxalate, m^1, medullary rays, *s*, sieve cells, *p*, parenchyma cells, *c*, cambium. (After Meyer.)

is dark gray, with [illegible] of foliaceous lichens with dark apothecia, yellowish brown lenticels, furrows and abraded patches, inner surface light yellow or light brown, finely striate or smooth; fracture short and even, the surface greenish in color. The structure of the stem bark is shown in Figure 238. It seldom yields more than 1.5 per cent of pelletierine.

The powdered barks are yellowish brown, with a slight odor and a marked astringency. The powder contains calcium oxalate rosettes and rhombohedra; numerous starch grains up to 10 microns in diameter; cork cells with strongly lignified walls; stone cells mostly single and up to 300 microns in length, the walls being very *thick* and strongly lamellated; tannin cells producing a deep blue color with solutions of ferric salts; wood fibers and tracheæ rare.

Pelletierine Tannate is a mixture in varying proportions of the tannates of the several *alkaloids* obtained from pome-

granate. It contains an amount of the alkaloids equivalent to not less than 20 per cent as the hydrochloride.

The ground bark is mixed with lime and extracted with chloroform. After conversion of the alkaloids to sulfate and solution in water, they are precipitated as tannate by the addition of tannic acid. Four alkaloids are present: pelletierine (punicine), the most important, is colorless, volatile and liquid, with levorotatory salts; isopelletierine, optically inactive, methylpelletierine with dextrorotatory salts; pseudopelletierine (methylgranatonine), in prisms and optically inactive.

Average dose of pelletierine tannate, 0.25 gm.

MYRTACEÆ, OR MYRTLE FAMILY

This is a family of about 73 genera and 2750 species. They are shrubs and trees, chiefly indigenous to Australia and tropical America. The plants yield a large number of economic products, and some, as the *Eucalyptus*, are to be classed among the leading timber trees of the world. The leaves are simple, the flowers are perfect, and the fruits are either fleshy and berry-like or capsular. In certain species of *Eucalyptus* the leaves are both horizontal and vertical, the former being bifacial, the latter centric, with a twist in its short petiole. Schizogenous excretory cavities are characteristic of this family, and are distributed throughout the parenchyma of the stems and leaves, giving to the latter pellucid-punctate areas. The secretory cavities arise very early in the development of the tissues and the secretion, which is of an oily nature, develops in a resinogenous layer lining the cavity, the walls of which finally become more or less suberized. The inner bark usually consists of alternating layers of bast fibers and sieve. The non-glandular hairs are usually unicellular, and glandular hairs are wanting.

EUCALYPTUS

[illegible] *alyp-*
and
rnia
-like
The
commercial supply of the drug is largely from southern France The tree requires much water and has been used for drying up marsh land

The leaves are up to 30 cm. long and 7 5 cm wide, coriaceous and with a revolute margin, leaf surfaces grayish green, glabrous, pellucid-punctate, with numerous small circular, reddish brown dots of cork, odor slightly aromatic; taste aromatic, somewhat bitter and cooling.

The epidermal cells are polygonal with straight walls and have a thick cuticle covered with wax; sunken stomata are found on both surfaces, the mesophyll consists mostly of palisade cells beneath each epidermis, among which are distributed large, spheroidal oil-secretion cavities with a yellow oily content; rosettes or single prisms of calcium oxalate are found in cells of the central loose mesophyll.

The drug contains volatile oil, 3 to 6 per cent, of which up to 80 per cent is eucalyptol (cineol), the remainder consisting of *d*-pinene (eucalyptene) and other terpenes; several resins, a neutral bitter principle; eucalyptic acid and tannic acid. Total ash, 5 25 per cent; acid-insoluble ash, about 0 2 per cent.

Eucalyptus Kino, Australian Kino or Red Gum (N. F. 1926 to 1936) is the
a ... pecies of *Eucalyptus*
I ... or garnet-red color
(... is Malabar kino and
contains 40 to 50 per cent of tannic acid; also kino red and catechin. From
...
an astringent.

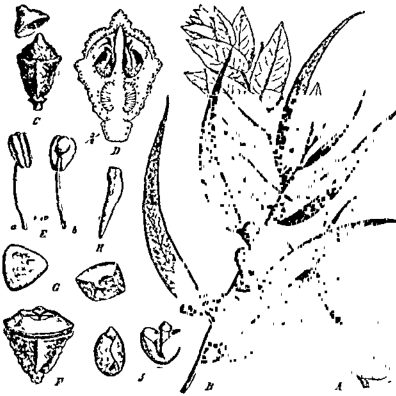


FIG. 23 ... oblong, dorsiventral, sessile le... scattered, bilateral leaves. (... operculum ... ion of or lid) which covers the stamens until the ... tures a flower-bud showing incurved filaments ... *H*. *E*, Stamens in two views. *F*, Truncated capsule or pyxis. *G*, ... Sterile seed, seeds of this kind usually being most numerous *J*, Two germinating plants (*A* to *F*, after Niedenzu, *G* to *J*, after Muller.)

Eucalyptus kino is also obtained from the following species: Iron-bark tree (*E. leucoxylon*), *E. gunnii*, *E. obliqua*, *E. piperata*, *E. ficifolia*, *E. stellulata*, *E. macrorhyncha*, *E. amygdalina radiata*. So-called Botany Bay kino was at one time supposed to be obtained from *Eucalyptus resinifera*.

Eucalyptus Oil (U. S. P. 1882 to date) is the volatile oil distilled with steam from the fresh leaves of *Eucalyptus globulus* Labillardiere, or from other species of *Eucalyptus*. The oil is a colorless or pale yellow liquid, having a characteristic, aromatic, somewhat camphoraceous odor, and a pungent, spicy cooling taste. Consult the *U. S. Pharmacopœia* for its constants.

STANDARDS.—Eucalyptus oil contains not less than 70 per cent of eucalyptol, which is determined by the freezing point, not below −15.4° C. Eucalyptus oil must be free from heavy metals and from eucalyptus oils containing large amounts of phellandrene.

USES AND DOSE.—Eucalyptus oil is an antiseptic and antiperiodic, a diaphoretic and an expectorant. Average dose, 0.5 cc

Some thirty species of Eucalyptus yield oils containing phellandrene; many others yield oils containing less than 70 per cent of eucalyptol, though phellandrine may be absent. Both of these types have been admixed with the official oil.

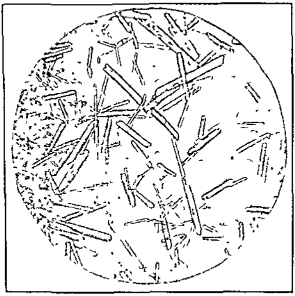


FIG. 240.—Crystals obtained by treating eucalyptol with 5 per cent hydroquinone solution.

Eucalyptol or Cineol [illegible]
oil and from other sour[illegible]
aromatic, camphorace[illegible]
oxygen atom in eucalyptol apparently does not possess alcoholic, ketonic, aldehydic or acid properties. Eucalyptol may be obtained (1) from eucalyptus oils by fractional distillation and subsequent freezing of the distillate or by treating eucalyptus oil with phosphoric acid and subsequently decomposing the eucalyptol-phosphoric acid with water; or (2) it may be obtained as a dehydration product of terpin hydrate on treatment with acids

Eucalyptol is optically inactive and should be free from oil of eucalyptus and phenols. Consult the U. S Pharmacopœia for its constants.

MICROCHEMISTRY OF EUCALYPTOL.—When a drop of eucalyptol (or a drop [illegible] he extract of eucalyptus leaf) [illegible] hydroquinone on a slide, color [illegible] with a 50 per cent solution of [illegible] vapors cause reddish yellow, branching crystals.

USES AND DOSE. Eucalyptol has properties similar to those of eucalyptus oil Average dose, 0.3 cc.

Oleum Cajuputi or **Cajuput Oil** (U. S. P. 1820 to 1936) is the volatile oil distilled ... several varieties by *Melaleuca leucadendron* ... The plants are found in the Philippines, th ... cajuput contains from 50 to 65 per cent of eucalyptol (cajuputol), terpineol and various terpenes. It is used externally as a parasiticide and internally as a carminative, stimulant and diaphoretic.

Other volatile oils containing eucalyptol include oils of lavender, levant wormseed, rosemary, sage, ginger, canella and cardamom.

CLOVE

Clove or Cloves (U. S. P. 1820 to date) is the dried flower bud of *Eugenia caryophyllata* Thunberg. *Eugenia* (Latin) and *caryophyllata* (Greek) mean "nut-leaf," and refer to the nut-like flower buds; "clove," from the Latin *clavus*, a nail, refers to the shape of the whole spice.

The plant is a tree up to 15 meters in height indigenous to the Molucca Islands but cultivated in Penang, Amboyna, Zanzibar, Sumatra, Madagascar, Seychelles, Mauritius and the West Indies: the buds are gathered when they change in color from green to crimson and are carefully dried in the sun. The best cloves come from Penang. Clove was known to the Chinese before 266 B.C. The Dutch, who won possession of the Spice Islands in 1605, endeavored to create a monopoly and destroyed all of the trees except those on the islands of Amboyna and Lernate. In 1770, however, the French succeeded in introducing the tree into Mauritius and the Isle of Bourbon from where its cultivation spread to other clove-growing areas.

DESCRIPTION, STRUCTURE AND POWDER.—See Figure 241 and the U. S. Pharmacopœia.

CONSTITUENTS.—Clove contains a volatile oil, 14 to 20 per cent; gallotannic acid, 10 to 13 per cent; caryophyllin, white, odorless, tasteless, crystallizing in silky needles, vanillin; eugenin, total ash, 6.15 per cent.

STANDARDS.—Clove yields, from each 100 gm., not less than 16 cc. of clove oil; not more than 10 gm. of crude fiber; and not more than 0.75 gm. of acid-insoluble ash ... cent of its stems and not more than 1 per cent of ...

USES AND ... a carminative and an aromatic. Average dose, 0.25 gm.

Clove Stems are subcylindrical, jointed, sometimes branching, brown, and less aromatic than clove, yielding from 4 to 7 per cent of volatile oil.

Clove Fruit (Mother of Cloves) is the nearly ripe fruit of the clove tree. It is about 2.5 cm. long, 10 mm. thick, ovoid, brown, 2- to 4-seeded and only slightly aromatic. Clove stem may be detected in powdered clove, by irregular or polygonal stone cells up to 70 microns in diameter, with thick porous walls and large lumina frequently filled with a yellowish brown amorphous substance, clove fruits contain starch. It is stated that artificial clove has been made by using starch, gum and oil of clove; or from dough and clove powder. This is easily disting... ...to water when the compound ... tion of the volatile ... ove is a by-product ... genuine.

Clove Oil or Oil of Cloves (U. S. P. 1820 to date; as clearing agent, U. S. P. 1916 to 1926; N. F. 1926 to date) is the volatile oil distilled with steam from the dried flower buds of *Eugenia carophyllata* Thunberg, and contains not less than 82 per cent by volume of eugenol.

Description.—It is a colorless or pale yellow liquid, becoming darker and thicker by age or exposure to air, and having the characteristic odor and taste of clove. For solubilities and constants consult the U. S. Pharmacopœia.

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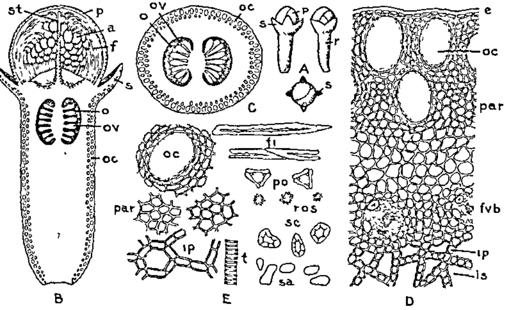


verse section through the receptacle at the location of the ovary showing the bilocular ovary (*o*), the ovules (*ov*) and oil cells (*oc*) *D*, Transverse section through the outer

ings by Harry Flower)

Eugenol (U. S. P. 1905 to date) is a phenol, $C_{10}H_{12}O_2$, obtained from clove oil and from other sources. It is usually prepared from clove oil by shaking with a 10 per cent solution of sodium hydroxide to form sodium eugenolate. The mixture is washed with ether, and the sodium eugenolate then decomposed with sulfuric acid, and the eugenol separated by steam distillation. It is a colorless or pale yellow, thin liquid, having a strongly aromatic odor of clove and a pungent spicy taste. Consult the U. S Pharmacopœia for its physical and chemical constants.

Microchemistry of Eugenol.—A very satisfactory microchemical test for eugenol either in volatile oils or in drugs consists of placing a drop of the oil (or of a chloroformic extract of the drug) on a slide, adding a drop of 3 per cent

aqueous solution of sodium hydroxide saturated with sodium bromide and covering with a cover glass. Almost immediately crystals of sodium eugenolate appear, which consist of needle and pear-like forms arranged in rosette-like bunches (see Fig. 242).

USES AND DOSE.—The properties of eugenol are similar to those of oil of cloves. Average dose, 0.1 cc.

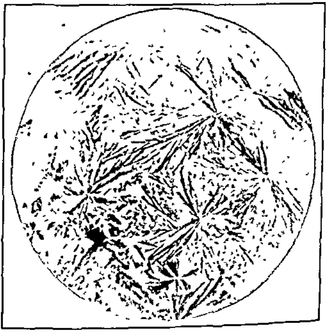


FIG. 242.—Crystals of sodium eugenolate

PIMENTA

Pimenta or Allspice (U. S. P. 1820 to 1916; N. F. *1916 to 1936*) is the dried nearly ripe fruit of *Pimenta officinalis*, a tree indigenous to the West Indies [illegible] especially [illegible]

pylotropous, plano-convex, slightly reniform, about [illegible] reddish brown, smooth, shiny.

For the structure see Figure 243.

The powder is dark brown, aromatic, and exhibits rosette aggregates of calcium oxalate up to 20 microns in diameter; single or compound *starch grains* from 3 to 20 microns in diameter; stone cells large, nearly isodiametric, very thick-walled [illegible] and nearly colorless content [illegible]; oil globules numerous; [illegible] with irregular reddish brown tannin masses; non-glandular hairs of the [illegible] very few.

Allspice contains a volatile oil (3 to 4 per cent), consisting of about 65 to 80 per cent of eugenol; a resin, an acrid fixed oil, about 6 per cent; and tannic acid; total ash 4 per cent; acid-insoluble ash, 0.15 per cent.

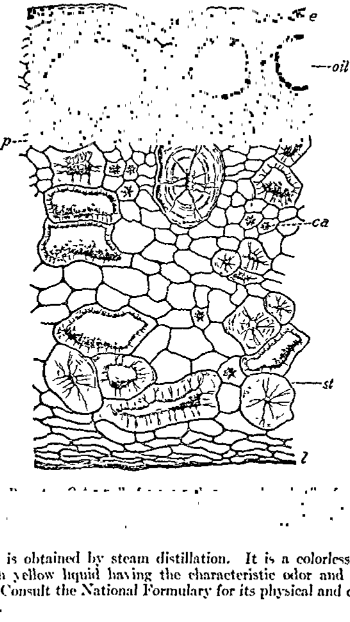
Pimenta is a stimulant, a carminative and an aromatic flavoring agent.

Ground allspice has been adulterated with clove stems, cocoa shells, and the endocarp of the olive.

ALLIED PLANTS.—A variety of *P. officinalis* yields a fruit with larger drupes, known as **Tobasco or Mexican Allspice.** The structure of this fruit resembles

that of pimenta, as does also the **Crown Allspice** obtained from *P. acris*, a tree of tropical America, the fruits of which are 8 to 10 mm. in length.

Pimenta Oil or Oil of Allspice (U. S. P. 1820 to 1926; N. F. 1926 to date) is a volatile oil distilled from the fruit of *Pimenta officinalis* Lindley, and yields not less than 65 per cent, by volume, of phenols calculated as eugenol.



The oil is obtained by steam distillation. It is a colorless, yellow or reddish yellow liquid having the characteristic odor and taste of allspice. Consult the National Formulary for its physical and chemical constants.

CONSTITUENTS.—Oil of pimenta contains from 65 to 80 per cent of eugenol; caryophyllene; cineol; phellandrene and methyl eugenol.

USES AND DOSE.—Oil of pimenta is a stimulant, a carminative and an aromatic. Average dose, 0.1 cc.

Myrcia Oil or Oil of Bay (U. S. P. 1882 to 1905; N. F. *1916 to date*) is a volatile oil distilled from the leaves of *Pimenta racemosa* (Miller) J. W. Moore, and yields not less than 50 per cent and not more than 65 per cent, by volume, of phenols.

The bay tree is a beautiful tree attaining the height of about 15 meters, growing in the West Indies. The leaves are distilled with steam to yield the oil, which is a yellow or brownish yellow liquid having a pleasant aromatic odor and a pungent spicy taste. Consult the National Formulary for its physical and chemical constants.

Constituents.—Myrcia oil contains from 55 to 65 per cent of eugenol; methyl eugenol; chavicol; methyl chavicol; phellandrene; citral and myrcene.

Uses.—*Myrcia oil is extensively employed in the perfume industry.* It is the principal constituent of Compound Myrica Spirit (Bay Rum).

Adulterants.—The leaves of two varieties of *P. acris*, known locally as "Bois d'Inde Citronelle" and "Bois d'Inde Anise," are frequently admixed with the leaves of the true Bay to the great detriment of the oil subsequently distilled. The oil from the "Citronella" variety (*P. acris* var. *citrifolia*) contains citral and has the flavor of lemon Why the oil from the "Anise" variety does not [illegible] clear. The varietal forms intermingle in [illegible] many of the West Indian Islands an[illegible] Much harm has already resulted to [illegible] concern to the distillers that either some method [illegible]; or that plantations of [illegible]

ARALIACEÆ, OR GINSENG FAMILY

This family consists of about *50 genera and 500 species* of plants which are widely distributed. They are perennial herbs, shrubs or trees. The leaves *are mostly palmately* lobed or compound; the flowers are small, perfect or polygamous, frequently occurring in umbels; the fruit is either a berry or a drupe. The plants possess schizogenous secretion canals in the parenchyma of pith, cortex and leaves. Sometimes the leaves are pellucid-punctate due to secretion cavities. In the root, resin canals are generally situated opposite the strands *of xylem* and phloem causing an exceptional displacement of the young lateral branches. The canals *and cavities may contain* volatile oil, resin, gum, and occasionally a milky content. In a number of species of *Aralia collateral medullary vascular bundles* are developed, which are inversely orientated, *i. e.*, the phloem is directed toward the center of the pith and the xylem in the direction of the cortex. Weiss has shown that these bundles in *Aralia racemosa* appear first as normal *bundles in the* peripheral ring and only enter the pith later, at the same time undergoing a rotation through 180 degrees. The leaves *are* usually glabrous, but in the floral parts both glandular and non-glandular hairs of several *different forms occur.*

ARALIA

Aralia, American Spikenard or Spignet (N. F. 1916 *to date*) consists of the dried rhizome and roots of *Aralia racemosa* Linné. The plant is a *perennial herb growing in rich woodlands* of the eastern United States

and Canada to a height of 1 or 2 meters and possesses a thick, fleshy rhizome; large, ternately-compound leaves; and numerous umbels of small, greenish flowers, which are arranged in large compound panicles. The fruits are small, bright reddish or purplish drupes and give the plant a very handsome and striking appearance. The drug is gathered in the fall and sliced to facilitate drying. It should be very carefully dried and preserved

DESCRIPTION.—Rhizome oblique, subcylindrical, more or less branched, 3 to 7 cm in thickness, externally light brown, distinctly annulate, with numerous deeply concave stem scars from 2 to 3 cm. in width; numerous, somewhat fleshy roots, up to 2 5 cm. in diameter

POWDER.—Light brown, aromatic, taste pungent and slightly acrid; starch grains
gates,
fibers
lignified cells [illegible] ngth and about one-half as broad,

CONSTITUEN[illegible] nt volatile oil, resin; tannin; total a[illegible] 0 55 per cent. The drug contains not more than 5 per cent of stem bases.

USES AND DOSE.—Aralia is a stimulant, an alterative and a diaphoretic. Average dose, 2 gm

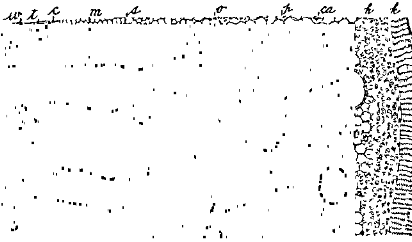


FIG 241 —*Aralia nudicaulis* Transverse section of rhizome showing cork (*k*), hypodermis (*h*), rosette aggregates (*ca*) of calcium oxalate, parenchyma (*p*) containing angular starch grains, oil-secretion canals (*o*), sieve (*s*), medullary rays (*m*), cambium (*c*), tracheæ (*t*), wood fibers (*w*).

Aralia Nudicaulis, American, Wild, or Virginian Sarsaparilla (U. S. P. 1820 to 1882) is the rhizome of *Aralia nudicaulis*, a nearly prostrate perennial herb, producing a very long rhizome, a solitary pinnately 3- to 5-foliate leaf and a naked scape with 2 to 7 umbels of green flowers The specific name *nudicaulis* means "naked stem," in allusion to the scape and rhizome of the species. The plant is common in most woodlands of the eastern United States and Canada.

The rhizome attains a length of many meters and is from 5 to 15 mm. in thickness, externally grayish brown, longitudinally wrinkled and somewhat annulate, fracture short, internally bark light brown, with numerous large oil-

secretion canals; wood yellowish, distinctly radiate; pith spongy, whitish; odor and taste *aromatic*.

The structure is shown in Figure 244.

The constituents are like those of Aralia. Total ash, 5 8 per cent; acid-insoluble ash, 0.2 per cent.

... the left is a

Aralia Nudicaulis has been used for the same purposes as Aralia. It is occasionally found as an adulterant of Aralia, but may be readily distinguished by the absence ...

Aralia S ... or Hercules Club (U. S. P. 1820 to 1882) is ... or tree growing on the banks of streams in the eastern United States

It occurs in quills, or transversely curved pieces, bark 1 to 3 mm in thickness; externally grayish brown, nearly smooth or irregularly wrinkled and ... ulate; ... cork

P...
ric...
to...
Korea and Japan. The roots are gathered from three- to six-year-old plants, carefully cleaned and dried. The drug is extensively used in China and it has been estimated that about 200,000 pounds of ginseng are exported annually fro... obtained from wild plants, bu... nsin, Michigan and Oregon. ... cm. in length, and 1 to 2.5 cm ..., distinctly annulate in the upper portion and terminated at the crown by one or more stem-scars; lower portion very much wrinkled, occasionally branching and marked by a number of root-scars; fracture short; internally light yellowish brown, marked by a distinct dark brown cambium zone, a distinctly radiate wood and numerous

thickened and marked on the upper surface by circular stem-scars, the fracture is horny; internally it is whitish, marked by small yellowish oil-secretion canals in the cortex, narrow wedges of collateral fibrovascular bundles separated by broad medullary rays and a large pith.

UMBELLIFERÆ, OR CARROT FAMILY

This is a family of about 270 genera and 2700 species of herbs, which are widely distributed, being most abundant in the temperate zones. The leaves are alternate and mostly decompound; the flowers are always arranged in umbels (Fig. 248); the fruit is a cremocarp, the morphological characters of which are relied upon in the taxonomic study of the species. The plants resemble the *Araliaceæ* in that schizog-

enous secretory canals are found in the cortex, pericycle, pith, leaves and fruits, the contents of the canals being volatile oil, resin or gum. There is usually a collenchymatous thickening of the cell walls of the primary cortex, corresponding to the ribs of the stems and fruits. Medullary vascular bundles occur in several modifications in the stem. The vascular bundles in the petiole are always isolated. The pith of the internodes is usually hollow. Calcium oxalate is in the form of rosette aggregates, or as solitary crystals. Non-glandular hairs are occasionally present and may be unicellular, stellate, multiseriate or abietiform. Glandular hairs are wanting.

ANISE

Anise or Aniseed (U. S. P. 1820 to 1926; N. F. 1926 to date) is the dried ripe fruit of *Pimpinella Anisum* Linné. *Pimpinella* is Latin meaning two-winged, referring to the bipinnate leaves; *anisum* is the old Arabic name for anise.

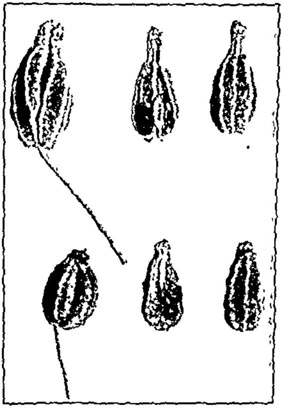


Fig. 246.—Italian anise, photo above, and Russian anise, photo below. Magnified six times. (Photo by Adamson.)

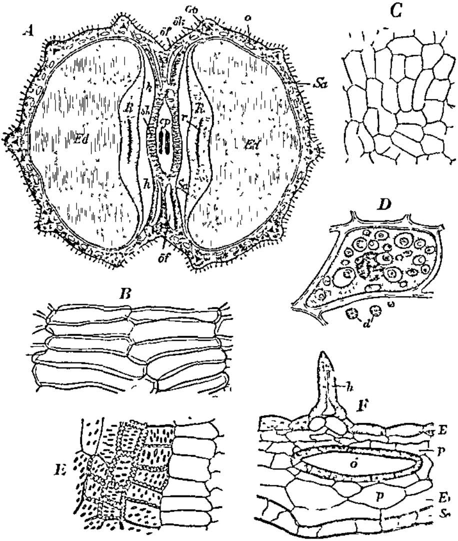
The plant is an annual herb indigenous to Asia Minor, Egypt and Greece, and cultivated in South America, Germany, Spain, Italy and southern Russia. The drug is derived from cultivated plants, and that obtained from Spain, known as "Alicante Anise," is preferred. Russian Anise is used chiefly for the distillation of the volatile oil.

Anise is among the oldest known medicines and spices. It was mentioned by Theophrastus, Dioscorides and Pliny and was one of the plants cultivated on the imperial farms of Charlemagne in the ninth century.

Description and Structure.—See Figures 246, 247 and the National Formulary.

Powder.—Color moderate yellowish brown to light olive brown; odor and taste agreeable, aromatic, and characteristic; non-glandular hairs, one-celled, up to 200 microns long, frequently curved, with numerous slight centrifugal projections, aleurone grains of the endosperm about 6 microns in diameter and enclosing a calcium oxalate rosette about 4 microns in diameter ... fragments of pericarp with light brownish, branching, oil tubes ... consisting of about 80 to 90 ... to 3 per cent), ... 4 per cent, calcium oxalate. Total ash, about ... 6 per cent

Uses and Dose.—Anise is an aromatic stimulant and carminative. It is also a diuretic and diaphoretic. It is largely used as a flavor. Anise fruits are used in certain types of bakery products of which the German Christmas cakes known as Springerle are an example. Average dose, 0 5 gm



[illegible] Transverse section of [illegible]

[illegible] Epidermis of seed coat. D, Cell of endosperm showing a number of aleurone grains [illegible]

Adulterants.—Italian anise may be admixed with conium, which is distinguished by the absence of hairs and vittæ and the presence of coniine; the

latter is determined by the development of the characteristic mouse-like odor on rubbing up the powder with alkalis or placing it in a solution of potassium or sodium hydroxide. The following microchemical tests may be useful in determining the presence of coniine, which occurs in the parenchyma and epidermal cells of the fruit; ammonium vanadate and sulfuric acid produce a blue color; iodine solution gives a reddish brown color; and picric acid gives a granular precipitate. Small lumps of clay and stones about the size of anise are frequently present.

Pimpinella or Pimpernel (N. F. 1916 to 1926), consists of the dried roots of *Pimpinella saxifraga* and *P. magna*. It occurs in fusiform pieces about 8 to 10 cm. in length, 4 to 10 mm. in diameter; externally yellowish brown; fracture short; internally whitish with numerous yellowish resin canals; the taste is acrid, pungent and aromatic. The drug contains a volatile oil; an acrid resin; a tasteless crystalline principle, pimpinellin; about 8 per cent of sugar; starch, and tannin. It is a diuretic and a diaphoretic.

Anise Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the dried ripe fruit of *Pimpinella Anisum* Linné or from the dried ripe fruit of *Illicium verum* Hooker filius, Fam. *Magnoliaceæ* (Chinese Star Anise Oil, U. S. P. 1882 to 1894, 1905 to date).

Anise Oil is obtained largely from Spain, southern Russia, and Bulgaria, while Star Anise Oil is distilled in southern China. The oils are much alike in constituents and physical properties. Anise Oil is a colorless or pale yellow strongly refractive liquid having the characteristic odor and taste of anise. Consult the Pharmacopœia for its physical and chemical constants.

CONSTITUENTS.—Anethole, from 80 to 90 per cent or more, methylchavicol; oxidation products, such as anisic aldehyde and anisic acid, terpenes such as *d*-pinene and phellandrene, and probably some safrol in the oil from star anise.

If solid matter has separated, carefully warm the mixture at a low temperature until it is completely liquefied, and mix it thoroughly before using. Oil of anise is free from phenols and heavy metals.

USES AND DOSE.—Anise Oil is a carminative and flavoring, used as a corrigent with cathartic remedies to prevent griping, and is frequently combined with licorice. Average dose, 0.1 cc.

Anethole *(N. F. 1916 to date) is parapropenyl* anisole, $C_6H_4C_3H_5OCH_3$. It is obtained from anise oil and other sources or is prepared synthetically. Anethole is a colorless or faintly yellow liquid at or above 23° C. At about 21° C. it solidifies to a crystalline mass which melts at 22° to 23° C. Anethole should be free from phenols, aldehydes and ketones. Consult the National Formulary for its physical and chemical constants.

USES AND DOSE.—Anethole is a carminative and flavor. Average dose, 0.1 cc.

FENNEL

Fennel or Fennelseed (U. S. P. 1820 to 1926; N. F. 1926 *to date) is* the dried ripe fruit of cultivated varieties of *Fœniculum vulgare* Miller. *Fœniculum* is Latin, meaning hay, in allusion to the odor of the plant.

The plants are perennial herbs (see Fig. 248) indigenous to the Mediterranean region of Europe and Asia, and cultivated in central and eastern Europe, Russia, India and Japan. The drug obtained from Saxony, Thuringia, Galicia and Russia is preferred.

DESCRIPTION AND STRUCTURE.—See Figures 249, 250, 253 and the National Formulary.

POWDER.—Yellowish brown; aromatic; endosperm fragments, colorless and

Total ash, 7.95 per cent; acid-insoluble ash, 0 45 per cent

USES AND DOSE.—Fennel is an aromatic stimulant, a carminative and a stomachic. It is used largely as a flavoring agent. Average dose, 1 gm.

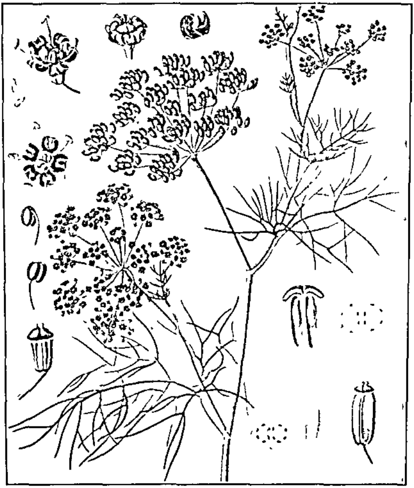


FIG. 248.—*Fœniculum vulgare*, showing the typical umbel (After Köhler.)

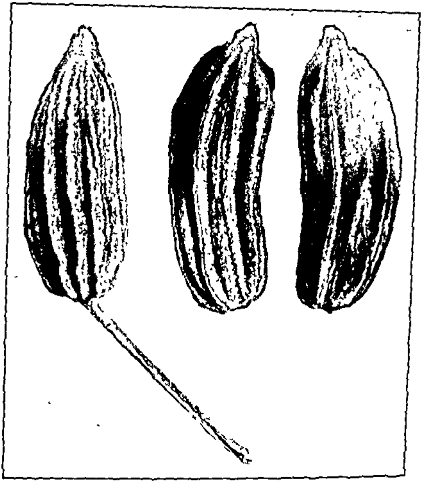


FIG. 249.—Fennel Fruit magnified 6 times (Photo by Adamson.)

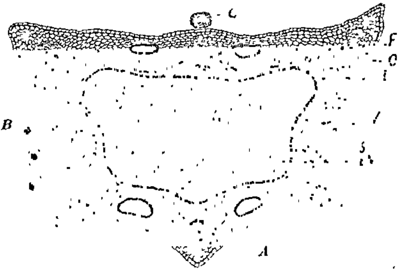


FIG. 250.—A, Transverse section through [illegible] ... pericarp, I, inner epidermis of pericarp, F, fi[illegible] ... S, seed coat, EN, endosperm. B, Isolated [illegible] ... fennel showing globoids and small rosette aggregates of calcium oxalate. C, ... through the carpophore, which is composed chiefly of sclerenchymatous cells.

Fennel Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the dried ripe fruit of *Fœniculum vulgare* Miller.

Oil of fennel is a colorless or pale yellow liquid, having the characteristic odor and taste of fennel. Consult the U. S. Pharmacopœia for its physical and chemical constants.

CONSTITUENTS.—Oil of fennel contains from 50 to 60 per cent of anethole,

phellandrene and fenchone.

If solid material has separated, the oil should be carefully warmed at a low temperature until it is completely liquefied and then thoroughly mixed. Oil of fennel is free from heavy metals

USES AND DOSE —Oil of fennel is a carminative, an aromatic and a flavor Average dose, 0.1 cc.

CARAWAY

Caraway, or Carawayseed (U. S. P. 1820 to date) is the dried ripe fruit of *Carum Carvi* Linné. The generic name *Carum* is probably from the Latin *carcum*, derived from Caria, a country of Asia Minor; *carvi* is Latin for *carvy*, the Scotch name for caraway. Medieval pharmacists called the drug *Carui* The plant is a biennial herb indigenous to

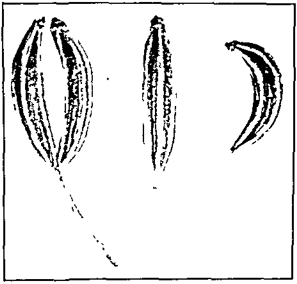


FIG. 251.—Caraway Fruits. Magnified 6 times (Photo by Adamson)

Europe and Asia and cultivated in England, northern Europe, Morocco and the United States, being naturalized in northern United States and parts of Canada. The drug is gathered when the fruits are ripe, that grown in Holland being preferred.

Caraway fruits were known to the Arabians who called them *Karawya*.

DESCRIPTION, STRUCTURE AND POWDER.—See Figures 251, 253 and the U. S. Pharmacopœia.

CONSTITUENTS.—Volatile oil, from 5 to 7 per cent; fixed oil; proteins; calcium oxalate. Total ash, 6.4 per cent, with about 0.5 per cent of acid-insoluble ash.

USES AND DOSE.—Caraway is an aromatic, a stimulant, a carminative; also a diuretic and a diaphoretic. Caraway fruits are used as a flavoring spice in

and about 35 per cent of a fixed oil.

Indian Dill-seed (*Peucedanum sowa*) has been sold as a substitute for caraway but it is very inferior to the Dutch caraway. **Mogador Caraway** from Morocco is suitable only for distilling oil for perfuming soap. **Levant Caraway** from Tunis, a novelty in the London market, is the most acceptable substitute for the Dutch article so far offered. **North Russian Caraway** is especially suited for the flavoring of the liqueur known as **kümmel**, but yields very little volatile oil.

Caraway Oil (U. S. P. 1831 to 1936; N. F. 1936 to date) is a volatile oil distilled from the dried ripe fruit of *Carum Carvi* Linné, and yields not less than 50 per cent by volume, of carvone.

Oil of caraway is a colorless or pale yellow liquid, with the characteristic odor and taste of caraway. Consult the National Formulary for its physical and chemical constants.

contains 50 to 60 per cent of the ketone ... with small amounts ... and the ... ticularly

simultaneous occurrenc ... interesting.)

USES AND DOSE.—Oil of caraway is a carminative, a stimulant and an aromatic. Average dose, 0.1 cc.

CORIANDER

Coriander or Corianderseed (U. S. P. 1820 to 1926; N. F. 1926 to date) is the dried ripe fruit of *Coriandrum sativum* Linné, and yields not less than 0.25 cc. of volatile coriander oil from each 100 gm. of drug. *Coriandrum is from the Greek Koris*, a bedbug, and refers to the disagreeable odor of the young plant; *sativus* means sown or cultivated. The plant is an annual herb indigenous to the Mediterranean and Caucasian region, *naturalized in the temperate parts of Europe and cultivated* there and in Africa and India. The fruit is threshed when full grown from cultivated plants and then dried. The drug from Russia and Thuringia is preferred.

Coriander was mentioned by the early Sanskrit writers and in the Mosaic books, Exodus and Numbers, and occurs in the papyrus of Ebers (1550 B.C.). Cato as well as Pliny also mention it and Charlemagne included it in the list of valuable products.

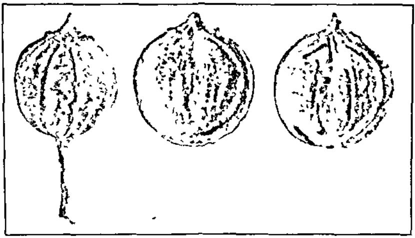
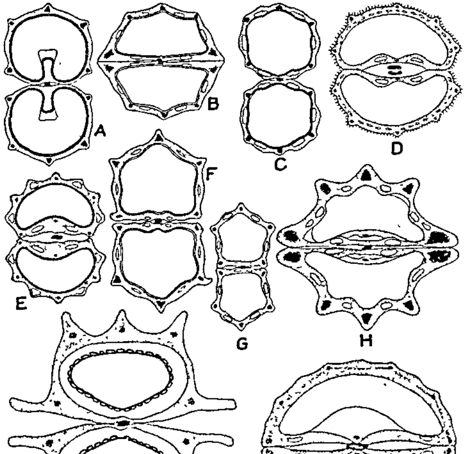


FIG 252.—Coriander Fruit. Magnified 6 times (Photo by Adamson.)



Description, Structure and Powder.—See Figures 252 and 253 and the National Formulary.

Constituents.—Volatile oil, 0.5 to 1 per cent; fixed oil, about 13 per cent; tannin; calcium oxalate. Total ash, about 5.3 per cent, acid-insoluble ash, 0.3 per cent.

Uses and Dose.—*Coriander is an aromatic stimulant and a carminative.* Average dose, 0.5 gm.

Allied Product.—**Bombay or Indian Coriander** is the fruit of a variety of *Coriandrum sativum* imported from Bombay. The fruits are oval and yield less volatile oil than the official drug.

Coriander Oil (U. S. P. 1882 to date) is the volatile oil distilled with steam from the dried ripe fruit of *Coriandrum sativum* Linné. Oil of coriander is a colorless or pale yellow liquid, having the characteristic odor and taste of coriander. Consult the U. S. Pharmacopœia for its physical and chemical constants.

Constituents.—Oil of coriander contains from 50 to 80 per cent of *d*-linalool (coriandrol); the hydrocarbons pinene and terpinene and small quantities of borneol and geraniol.

Uses and Dose.—Oil of coriander is a carminative and an aromatic. Average dose, 0.1 cc.

CELERY FRUIT

Celery Fruit or Celeryseed (N. F. 1916 to 1947) is the dried ripe fruit of *Apium graveolens* Linné. *Apium* is the Latin for parsley and refers to the resemblance between the two plants; *graveolens* is Latin meaning to emit a heavy odor. The plant is a biennial herb, indigenous to England and extensively cultivated throughout the temperate regions of Europe and the United States, for its succulent leaf-stalks or fleshy roots and in France for its aromatic fruits, all of these being used for culinary purposes.

Celery Fruits Fig. 254.—Magnified 6 times. (Photo by Adamson.)

The fruits are also used to a limited extent in medicine.

Description, Structure and Powder.—See Figures 253, 254 and the National Formulary, Seventh Edition.

Constituents.—A cc … nt, consisting of *d*-limonene and 90 pe … y leaves yield about 0 1 per cent of a … and forming a clear solution with 10 parts of 90 per cent alcohol.

Standards.—Celery fruit contains not more than 5 per cent of foreign organic matter, and yields not more than 3 per cent of acid-insoluble ash, and not less than 1.75 cc. of volatile oil of celery fruit from each 100 gm. of drug.

Uses and Dose.—Celery fruit is an aromatic stimulant, a carminative and a stomachic. Average dose, 1 gm.

Unofficial Umbelliferous Fruits

C[illegible] or Poison Hemlock (U. S. P. 1831 to 1863, 1873 to 1916; N. F. 1916 … [illegible] a large … America … but still … of this green, from wild plants, and carefully [illegible] … plant entered into the famous hemlock potion of the Greeks and was employed

by them in putting their criminals to death. Tradition has it that Socrates was put to death with a decoction of this plant

The mericarps are usually separate; the cremocarp is broadly ovoid, slightly compressed laterally, 3 to 4 mm. in length, about 2 mm. in diameter with a

somewhat reniform in cross-section and without vittæ; seed reniform, with a

acrid.

For the structure see Figures 253 and 256

FIG 255

FIG 256

FIG. 255 —Conium Fruit. Magnified 6 times (Photo by Adamson)

FIG 256 —Cross-section of a mericarp of conium c, c commissural surface, e, portion without secondary ribs, o, portion showing slight development of secondary rib, o', secondary rib, v, fibrovascular bundle of pericarp (m), t, t', layer containing conine, a, endosperm, b, tissue of the embryo. (After Flückiger)

The constituents are the liquid alkaloid coniine (hexahydropropyl pyridine), 0 5 to 3 per cent, conhydrine (hydroxyconine), in plates, dextrorotatory, and very poisonous; pseudoconhydrine (an isomer of conhydrine), in needles; γ-coniceine, a colorless, oily alkaloid with a disagreeable odor and 18 times more ... cent

... adily ... rless, ... omes

blood-red and afterwards green, with concentrated sulfuric acid Phosphotungstic acid and Marme's reagent are the most satisfactory reagents for the microcrystalline identification of conine The disagreeable odor in commercial conine, as well as in conium, is due to the alkaloid coniceine.

Conium is an antispasmodic, a sedative and an anodyne It acts on the peripheral ganglia in a manner similar to nicotine. Conium was formerly used to a considerable extent in medicine, but today has fallen into almost complete

disuse. It is of considerable interest, however, that coniine was one of the first alkaloids discovered (1827) and the first to be prepared synthetically (Ladenburg, 1886).

The entire fresh plant of *Conium maculatum* is used in the preparation of **Succus Conii** (U. S. P. 1873 to 1882). It probably contains the same constituents as the fruit, but in smaller amounts. The root contains 0 018 to 0 047 per cent of total alkaloids; the stems 0.064 per cent; the leaves 0.187 per cent and the flowers and flower stalks 0.236 per cent. Dried conium leaves and flowering tops, **Conii Folia** (*U. S. P. 1820 to 1882*) have been used in medicine for the same purposes as conium fruit.

Æthusa, the poisonous leaves of the Lesser Hemlock or Fool's Parsley (*Æthusa cynapium*) [illegible] rhomboid-oval, deepl [illegible] narrow to linear, abru [illegible]

Water Hemlock (*Cicuta maculata*) is a stout perennial herb growing in wet meadows throughout the United States and Canada. The stems are streaked with purple, the leaves are pinnately compound, the leaflets being oblong-lanceolate and coarsely serrate; the flowers are white, occurring in large compound umbels. The fruit is ovoid, with prominent ribs and six conspicuous vittæ. The rhizome is large and fleshy and is sometimes mistaken for parsnip; it contains a resinous substance, cicutoxin, which is quite poisonous The fruits contain a volatile alkaloid, cicutine, resembling coniine, and a volatile oil resembling oil of cumin.

Petroselinum or Parsley Root (U. S. P. 1820 to 1872; N. F. 1916 to 1926) and ***Petroselinum, Parsley Fruit or Parsleyseed*** (*U. S. P. 1916 to 1926*) are the dried root and the dr [illegible] Hoffman. The plant is a b [illegible] time there was not a salad or sauce [illegible] The fruits are gathered in the fall and carefully dried

The root drug occurs in irregular slices, light yellowish in color, with short fracture, and containing numerous oil-secretion canals Odor is aromatic, taste sweetish and slightly pungent The fleshy root may be cooked and eaten like parsnips.

The f[illegible] *with the usual appearance and structure of* [illegible] and 253. The fruit contains 1 to 3 per ce [illegible] optene, apiol, and a terpene, probably *l*-pinene a fixed oil, 6 per cent, resinous substances, 5 per cent; mucilage, 7 per cent, fat, resembling stearic acid, 16.5 per cent; phyteumacolla, combined with potassium salts, 12 5 per cent; protein substances, combined with calcium phosphate, 3 per cent; crude fiber, 48.5 per cent; ash, *4 to 6 per cent.*

Parsley fruits and herb are extracted with ether to prepare the oleoresin known as **Liquid Apiol** (U. S. P. 1916 to 1926). It is a dark green, thick, oily, non-volatile liquid with an aromatic odor. If only the ripe fruit is used, the extra [illegible] ula [illegible] in [illegible] fruit of the East Indian Dill, *Peucedanum sowa*, which is apparently isomeric with the apiol from parsley oil.

Heracleum, Masterwort or Cow-parsnip (U S P. 1820 to 1863) is the root of *Heracleum lanatum* Linné. The plant is a wooly perennial herb growing up to 3 meters high in northern and central United States to the *Pacific Ocean.* All parts of the plant have a rank odor and a pungently acrid taste The root, leaves and fruit have been employed medicinally. A volatile oil, a resin and acrid principles are present in the plant. It has been employed as a vesicant

(fresh leaves), a counter-irritant and as a gastro-intestinal irritant. Dose, up to 4 gm.

Carrot Fruit or Wild Carrotseed (U. S. P 1820 to 1882) is the ripe fruit of *Daucus Carota* Linné. The fruit is small, about 3 mm. long, and has a slightly aromatic odor and a pungent taste. The root of the wild plant is thin, spindly, woody, white, of an aromatic odor and a pungent, bitter taste The fruit is used as a diuretic, stimulant and a menstrual excitant.

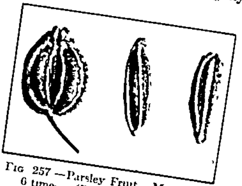


Fig 257 —Parsley Fruit Magnified 6 times. (Photo by Adamson)

Eryngo or Button Snakeroot (U. S. P 1820 to 1873) is the rhizome of *Eryngium yuccæfolium*, a plant with long, grass-like, fringed, radical leaves, a tall flower stalk, with short leaves and a dense head of white flowers. It is found in pine barrens and prairies from New Jersey to Wisconsin and southward.

The rhizome consists of a short root stalk and numerous branches with a heavy aromatic odor and an aromatic, sweetish, somewhat acrid taste It was used as a diaphoretic, expectorant and emetic.

Anethi Fructus or Dill Fruit consists of the dried ripe fruit of *Anethum graveolens* The plant is a small annual herb indigenous to southern Europe and cultivated in England, Germany, Roumania, and the United States It is used

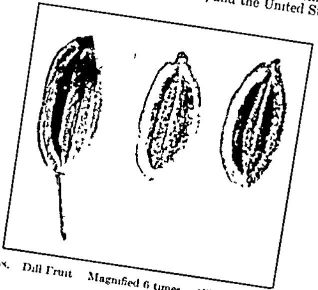


Fig. 258. Dill Fruit Magnified 6 times (Photo by Adamson)

extensively as a pickling spice, and like other umbelliferous fruits has carminative and stimulant properties The oil is usually distilled from the fresh or partially dried, whole herb when in fruit, much as peppermint oil is prepared

Angelica or Angelica Herb (U S. P. 1820 to 1863); **Angelica or Angelica Root** (U S P. 1863 to 1873, N F. 1916 to 1936); **Angelicæ Fructus, Angelica Fruit or Angelicaseed** (U. S. P. 1831 to 1842; N F. 1916 to 1936) are the dried leaves and flowering tops, the rhizome and roots; and the ripe fruit, respectively, of *Angelica archangelica* Linné and of other species of *Angelica*.

The plant is a biennial, up to 2 meters tall, indigenous to northern Europe

and Siberia, extensively cultivated in Hungary, Germany, and to some extent in the United States. The fresh stalks are "candied" and used as an aromatic flavoring in cookery.

Angelica Oil, from the herb, about 0.1 per cent; from the root, 0.35 to 1 per cent; and from the fruit, about 1 per cent, is nearly colorless when fresh, but becomes brownish on keeping, and the odor resembles a mixture of pepper and musk.

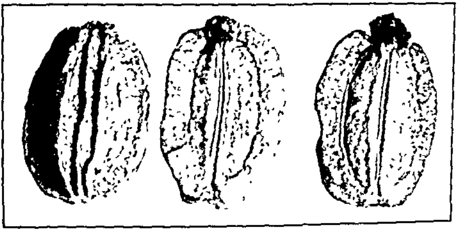


Fig. 259.—Angelica Fructus. Magnified 6 times. (Photo by Adamson.)

The large, fleshy roots are gathered in the fall, sliced, carefully dried, and preserved against insects. The fruits are large, up to 8 mm. in length, with 6 strong ribs or wings, and about 20 large oil canals (see Figs. 253 and 259).

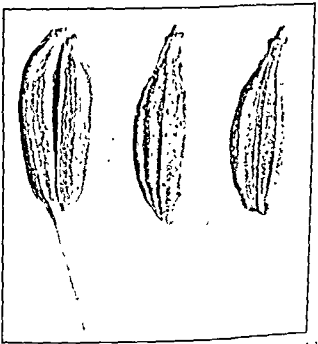


Fig. 260.—Cumin Fruit. Magnified 6 times. (Photo by Adamson.)

Angelica is an aromatic, a stimulant, a carminative and a stomachic. Average dose of root or fruit, 1 gm.

Cumin consists of the dried ripe fruit of *Cuminum cyminum*, a small annual l and most commercial supplies uts are about 6 mm. long and with short bristly hairs. The fruits contain from 2 to 4 per cent of a volatile oil which consists of from 25 to 35 per cent of cuminic aldehyde. It was a common spice in the Middle Ages but is now principally employed in veterinary practice.

Sumbul or Musk Root (U. S. P 1882 to 1926, N. F 1926 to 1947) consists of the dried rhizome and roots of *Ferula sumbul* (Kaufmann) Hooker filius, or of other closely related species of *Ferula* possessing a characteristic musk-like odor *Ferula* is the Latin name for the fennel plant, from the Latin *ferio*, to strike, *sumbul* is from the Arabic, signifying an ear or spike The plant is a perennial herb indigenous to Turkestan. The root has long been used in India and Persia as a perfume and incense in religious ceremonies. Russian physicians were the first to employ it in Europe and it still enters the European markets by way of Leningrad.

The drug occurs in transverse segments, up to 7 cm. in diameter, and floats in water, externally brown, distinctly annulate, periderm easily separable, the upper part of the rhizome with occasional circular scars, stem bases and leaf short, irregular, but fibrous; inter- the wood wedges irregular, due to

The cork is thin with yellowish brown cell walls, cortex of irregularly twisted strands of sieve and parenchyma, easily separable, radiate wood wedges and medullary rays; pith small. The oleoresin secretion canals are large, uniseriate, numerous, with reddish brown or brownish black contents

The powder is grayish brown to dark brown, odor musk-like, taste bitter and pungent, tracheæ usually with scalariform perforations; large, irregular, brownish black fragments of oleoresin canals or reddish brown fragments of

and several acids, as angelic, valerianic and methyl crotonic Total ash, 5.18 per cent with about 0 85 per cent of acid-insoluble ash

Sumbul is a carminative, an antispasmodic and a nervine Average dose, 2 gm

ASAFETIDA

Asafetida or Gum Asafetida (U. S P. 1820 to 1942; N F. 1942 to date) is the oleo-gum-resin obtained by incising the living rhizomes and roots of *Ferula Assa-fœtida* Linné and *Ferula fœtida* (Bunge) Regel and of other species of *Ferula* The Latin, *Asa*, means gum, or the Arabic *aza*, means healing, and the Latin *fœtida* refers to the ill-smelling, offensive odor of the drug

The plants are perennial branching herbs, up to 3 meters high, indigenous to eastern Persia and western Afghanistan. The drug is collected as follows (1) Remove the soil from the upper part of the large root; (2) transversely cut off the root crown, (3) protect the cut surface from the sun, (4) scrape off and save the milky exudation, (5) repeat the process every week or so during the summer or until the root is exhausted. Most of the drug is collected in eastern Persia and Afghanistan. Under the name of *Laser*, a substance supposed to be asafetida has been used in Persia and India since time immemorial. It appears in

Sanskrit works under the name of *Hingu*. It has long been employed by the Arabs, who no doubt introduced it into Europe during the Middle Ages.

DESCRIPTION.—A soft mass, sometimes almost semi-liquid, or in irregular masses of agglutinated tears, or in separate ovoid tears, from 1 to 4 cm. in diameter, which when fresh are tough, yellowish white and translucent, changing gradually to pinkish, violet-streaked, and finally reddish brown, and becoming, on drying, hard and brittle; internally the tears are milky white and opaque; odor persistently alliaceous; taste bitter, alliaceous and acrid.

To powder asafetida, which always impairs its quality, it is first dried at a temperature not higher than 30° C. or placed over freshly burned lime. It is comminuted, preferably at a low temperature, and diluents of starch or magnesium carbonate are sometimes added, in order to preserve it in the powdered form. It should be kept in tightly closed bottles.

CONSTITUENTS.—Resin 45 to 60 per cent; volatile oil 3 to 17 per cent; gum up to 25 per cent The reddish brown amorphous resin (consisting of the ferulaic ester of asa-resinotannol) yields on dry distillation, umbelliferon; on treatment with sulfuric

catechuic acid. Tl

pinene and cadinine

related to vanillin,

and formic, acetic,

per cent of total ash, almost entirely soluble in diluted hydrochloric acid; dirty agglutinated drug may yield up to 50 per cent of total ash; carefully prepared drug yields less than 10 per cent of total ash.

STANDARDS AND TESTS.—Asafetida yields not less than 50 per cent of alcohol-soluble extractive and not more than 15 per cent of acid-insoluble ash. Asafetida yields a milk-white emulsion when triturated with water, which becomes yellowish on the addition of alkali solution. For tests of identity and purity, see the National Formulary.

USES AND DOSE.—Asafetida is a stimulant, an expectorant, an antispasmodic and a laxative. Average dose, 0.4 gm.

ADULTERANTS.—Asafetida may contain other gum-resins, as galbanum or ammoniac, colophony, fragments of vegetable tissues, red clay, sand and stones; it is sometimes adulterated with dirty white, gritty masses of gypsum, at other times with barley or wheat flour or translucent gums.

Ammonia(... *Dorema*

ammoniacum ... and the

... through-

deserts near the Arabian Sea. The gum-resin occurs in ...

out the plant, exudes as a result of insect punctures and hardens upon the stems and petioles. Mos ... where it is garbled. It occurs

in irregular, somew

agglutinated into

... distinct; taste bitter and acrid.

... becoming

reddish

or yello

1 part of finely powdered am

the solution filtered, and an

show no blue fluorescence (absence of galbanum).

Ammoniac contains a volatile oil, from 0.2 to 0.4 per cent; an acid resin (which is an ester of ammoresinotannol and salicylic acid); an indifferent resin, from 60 to 70 per cent; a gum resembling acacia, from 12 to 16 per cent; a trace of free salicylic acid, several volatile acids, acetic and caproic; ash from 2 to 10 per cent. None of the constituents contains either sulfur or umbelliferon.

Ammoniac is a stimulant, a carminative, an antiseptic and an expectorant.

fragments of vegetable tissues, from 0.5 to 7 cm. in diameter, externally bluish
the surface;
and brittle;
shiny, odor

Galbanum is only partly soluble in water or alcohol. When triturated with water, it yields a turbid milky fluid, which upon the addition of a drop of ammonia water assumes a bluish fluorescence. When galbanum is boiled with hydrochloric acid and the solution allowed to stand for an hour, it becomes bright red, changing to dark violet upon the addition of an equal amount of

cent of galbaresinotannol and 0.25 per cent of free umbelliferon. Gum and impurities up to 27 per cent, and ash 16 to 20 per cent.

Galbanum is a stimulant, a carminative, an expectorant and an antispasmodic.

Microchemistry of Asafetida, Ammoniac and Galbanum

Asafetida, ammoniac and galbanum are usually designated as gum-resins, they are, however, oleo-gum-resins since they contain variable quantities of volatile oil. Each contains about 20 per cent of gum, the remainder consisting largely of resins composed of resinotannols combined with salicylic acid, umbelliferon or ferulic acid.
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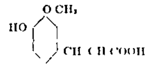
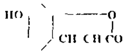
and


Ferulic acid


Umbelliferon

Salicylic Acid may be demonstrated in ammoniac by microsublimation. Add a drop of hydrochloric acid to a few milligrams of ammoniac, cover with a
be used or the
Salicylic acid
y taking up in
Silver nitrate
ic sublimate of
ferric chloride
solution

CORNACEÆ, OR DOGWOOD FAMILY

This is a small family of shrubs and trees, comprising 16 genera and 85 species. The leaves are simple or opposite, and the flowers are arranged in cymes or heads, which in the case of the flowering dogwood (*Cornus florida*) are subtended by 4 large, petal-like, white or pinkish bracts. The pericycle contains isolated groups of bast fibers, or is made up of a composite and continuous ring of sclerenchyma. Secretory elements are seldom present. Calcium oxalate occurs as rosette aggregates, solitary crystals or microcrystals. The non-glandular hairs are mostly unicellular and are sometimes provided with verrucose thickenings of the cuticle. Glandular hairs of a number of special forms are present.

Cornus Circinata or Round-leaved Dogwood (U. S. P. 1820 to 1882); **Cornus, Cornus Florida, or Common Dogwood** (U. S. P. 1820 to 1894; N. F. 1916 to 1936); **Cornus Sericea or Swamp Dogwood** (U. S. P. 1820 to 1882) are, respectively, the dried bark of *Cornus circinata;* the dried root bark of *Cornus florida* Linné; and the dried bark of *Cornus sericea*

Cornus florida is a small tree, rarely 12 meters high, and the other two plants are shrubs, all indigenous to the eastern United States from Canada to Virginia and Tennessee.

These three bark drugs, both from the stem and the root, are bitter and astringent, though the root barks usually contain more of the bitter principle, cornin, than do the stem barks. Cornus Sericea is more astringent than Cornus Circinata, more bitter than Cornus Florida The "eclectic" cornin is a hydroalcoholic dry extract prepared from Cornus Florida; it is strongly bitter and astringent

The Cornus barks have been used as bitter tonics, during the Civil War, Cornus Florida was used in place of cinchona as an anti-malarial. Average dose, 2 gm. For a complete description of Cornus Florida see the National Formulary, Fifth Edition.

ERICACEÆ, OR HEATH FAMILY

This is a large family of nearly 1500 species of very wide geographic distribution; the species are mostly shrubs, erect or prostrate, occasionally small trees, and rarely herbs The plants vary in their morphological characters; both glandular and non-glandular hairs commonly occur in a variety of forms.

The family can be divided on morphological grounds into 3 subfamilies: (1) the *Ericoideæ* proper, in the flowers of which the calyx is free from the ovary, and the stomata are surrounded by more than 2 epidermal cells. This subfamily includes *Rhododendron, Kalmia, Epigæa, Gaultheria* and other heath-like plants. (2) The *Vaccinioideæ.* or Whortle-Berry subfamily, in the flowers of which the calyx adheres to the ovary, the latter developing into an edible berry-like fruit, surmounted by the short calyx teeth. The stomata have 2 neighbor cells which lie parallel to the pore. This subfamily includes the blueberry and huckleberry plants. (3) The *Monotropoideæ,* or Indian Pipe subfamily are saprophytes and include the Indian Pipe and Beech Drops. Those *Ericaceæ* in which the flowers have a polypetalous corolla are

sometimes placed in a separate subfamily, the *Pyroloideæ*, which comprise about 20 species, *Pyrola*, *Chimaphila* and possibly 2 other genera.

FIG. 261.—Bearberry (*Arctostaphylos uva-ursi*), a trailing shrubby plant with thick evergreen, alternate leaves and whitish flowers in terminal racemes. The fruit is a globular, reddish, berry-like drupe about the size of a pea, with a mealy insipid pulp. *A. alpina* growing in the Alpine summits of Maine and New Hampshire, develops a blackish drupe with a juicy and edible pulp. (U. S. Bureau of Plant Industry.)

UVA URSI

Uva Ursi or Bearberry (U. S. P. 1820 to 1936, N. F. 1936 to date) is the dried leaf of *Arctostaphylos Uva-ursi* (Linné) Sprengel or its

varieties *coactylis* or *adenotricha* Fernald and MacBride. Both the generic and specific names mean "bear berry," the old Indian name; Greek: *Arctos*, bear; *staphyle*, bunch of grapes; Latin: *Uva*, grape or berry; *ursi*, bear. The plant is a procumbent evergreen shrub indigenous to Europe, Asia and the northern United States and Canada.

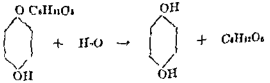
The green leaves only are gathered in the autumn. The commercial supply is largely from the United States and Canada and to some extent from Europe. The leaves are used in Sweden and Russia for tanning "Russia" leather, which receives its aroma from oiling with Oleum Rusci (see page 209). The drug was formerly highly valued in European medicine as an astringent. It was introduced into American medicine about 1800.

DESCRIPTION.—Obovate, spatulate, 12 to 30 mm. in length, 5 to 13 mm. in breadth; summit obtuse; base acute, tapering; margin entire, slightly revolute; upper surface dark green, glabrous, finely reticulate; undersurface yellowish green; petiole about 3 mm. in length, slightly pubescent; texture coriaceous, brittle.

POWDER.—Color dusky yellow to light olive; odor slightly aromatic, tea-like; taste astringent, somewhat bitter, epidermal fragments with broadly elliptical stomata and 5 to 8 poly...
spiral tracheæ, narrow, strongly
crystal fibers with monoclinic pr
fibers, lignified, irregular, with thick, porous, tuberculated walls and curved ends; hairs unicellular, non-glandular, short, serpentine or straight, or glandular with a short stalk and a small, one-celled head; numerous fragments of parenchyma that turn bluish black upon the addition of ferric chloride T.S.

CONSTITUENTS.—T...
principle, ursone, tan
crystalline, coloring p
acid-insoluble ash, about 0.25 per cent. Ericolin is a yellow, hygroscopic, bitter substance, which yields on hydrolysis the volatile oil, ericinol. Ursone occurs in tasteless needles, insoluble in water but sublimable.

Arbutin is a phenol glucoside which forms colorless, bitter needles and is soluble in water and alcohol, the solutions being colored azure blue upon the addition of an alkali followed by phosphomolybdic acid. Upon hydrolysis, it yields hydroquinone.



Arbutin Hydroquinone Glucose

If powdered uva ursi is microsublimed, a sublimate of hydroquinone will readily be formed. **Hydroquinone** is dimorphous, and hexagonal monoclinic plates ... of the ... Arbutin sublim... bright

more than 3.5 per cent of

the stems of the plant and not mo
matter, and yields not more than 1
or in the powder, vanillic acid colors the cells ...
ursi from the leaves of *Vaccinium myrtillus*. Sections of leaves of uva ursi are

colored bluish black with freshly prepared solutions of ferrous sulfate, distinguishing them from the leaves of *Vaccinium vitis idæa* Prepare an aqueous extract by boiling 1 gm. of powdered uva ursi in 10 cc of water, cool, filter and add a few drops of ferrous sulfate T.S.: a grayish purple precipitate is formed

USES AND DOSE.—Uva Ursi is an astringent, a tonic and a diuretic. Average dose, 2 gm.

ALLIED PLANTS.—Various other species of *Arctostaphylos* contain principles similar to uva ursi The leaves of **Trailing Arbutus** (*Epigæa repens*) contain ericolin and possibly arbutin Ericolin occurs in a number of species of *Ledum* and *Rhododendron* and also in **European Huckleberry** (*Vaccinium myrtillus*), a small cranberry (*Vaccinium oxycoccus*) and **Heather** (*Calluna vulgaris*).

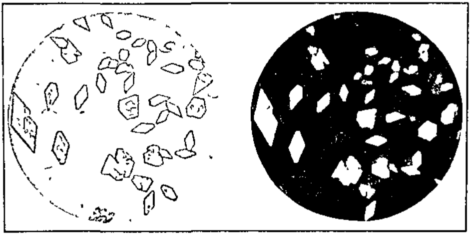


FIG 262.—Hydroquinone sublimed from Uva Ursi *A*, In normal transmitted light, *B*, in polarized light.

acids.

The leaves of *Empetrum nigrum* contain resin, benzoic acid, tannin, a wax, fructose and probably rutin.

Chimaphila or Pipsissewa (U. S. P. 1820 to 1916; N F 1916 to 1947) is the dried leaf of *Chimaphila umbellata* (Linné) Barton. *Chimaphila* is from two Greek words meaning winter loving, in allusion to the leaves, green in winter, *umbellata* refers to the flower cluster; Pipsissewa is the American-Indian name for the plant

The plant is a low perennial herb indigenous to the United States and southern Canada, northern Europe and Siberia The commercial supplies come mostly from Michigan, Virginia and North Carolina. The North American Indians considered Chimaphila an important medicine.

POWDER.– See Figure 263 and the National

occurring in golden yellow needles; two

e Uva Ursi), several other crystalline prin-

per cent. Total ash about 4 per cent with about 0.25 per cent of acid-insoluble ash. Since arbutin is present, hydroquinone

may be microsublimed from powdered chimaphila, and identified by the usual microchemical tests.

Chimaphila is an astringent, a tonic and a diuretic. Average dose, 2 gm

Pyrola Maculata, Chimaphila Maculata or Spotted Wintergreen (U. S P. 1831 to 1842) resembles in plant characteristics, constituents and medical properties the drug Chimaphila to which, botanically, it is closely related The leaves of *C. maculata* have lighter irregular spots on the dark green upper surface.

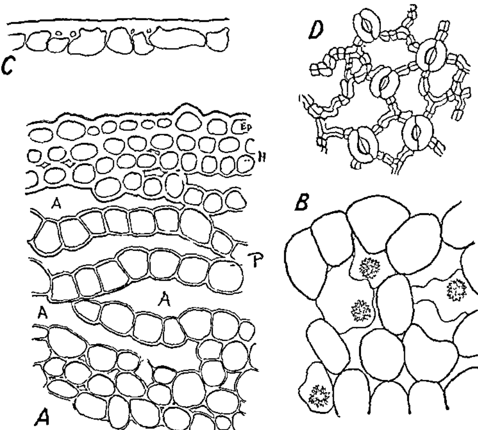


FIG. 263.—*Chimaphila umbellata*· *A*, transverse section of an aerial internode, *Ep*, ... hypodermis composed of thick-

pit ... oxalate.
ver ... er walls
C, ... pidermis
D, Surface view of the dorsal epidermis showing the thick, porous cells, and the characteristic stomata which lack neighbor cells. The guard cells of the stomata are slightly raised above the surrounding epidermis, and the wide air-chambers are very shallow (After Holm)

Gaultheria, Wintergreen, Teaberry or Checker-berry (U. S. P. 1820 to 1894) consists of the dried leaves of *Gaultheria procumbens*, a low shrub-like perennial, producing slender creeping or subterranean stems, the branches ascending and from 5 to 15 cm. in height. The leaves ar ... the flowers are white and axillary and the fruit is a ... rry. The plant is very common in coniferous ... ited States and Canada The leaves are coriaceous, the upp ... reen ... le green. The odor is distinct, aromatic

For the structure see Figure 264.

Oleum Gaultheriæ, Oil of Wintergreen or Methyl Salicylate (U. S. P. 1820 to date) is obtained from *Gaultheria* plants by steam distillation. The yield from the dry leaves ranges from 0 5 to 1 per cent.

green plants, chopped into small pieces and allowed to *stand in water for about twelve* hours; it may be purified by *rectification*. For Standards and Tests see Methyl Salicylate, U. S. Pharmacopœia

Owing to the demand for this oil and its high price, as compared with artificial methyl salicylate, it may be substituted by oil of birch or the artificial methyl salicylate.

Gaultheria is a stimulant, a diuretic and an astringent

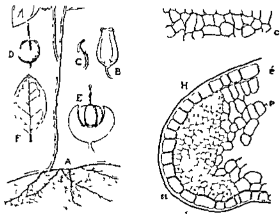


Fig 264 —*Gaultheria procumbens* *A*, entire plant showing horizontally creeping stolons and solitary axillary flowers, *B*, flower showing hypocrateriform corolla, *C*, stamen, *D*, young fruit; *E*, section of fruit showing the baccate or berry-like calyx which encloses the true fruit or capsule, *F*,

Methyl Salicylate, Gaultheria Oil, Wintergreen Oil, Betula Oil or Oil of Sweet Birch (U S. P 1894 to date) is produced synthetically or is obtained by maceration and subsequent distillation with steam from the leaves of *Gaultheria procumbens* Linné or from the bark of *Betula lenta* Linné (Fam. *Betulaceæ*). The product must be labelled to indicate whether it is synthetic or distilled *from either of the plants mentioned*.

The recovery of the oil from gaultheria has been discussed above. When recovered from birch the process is essentially the same. *Methyl* salicylate is made synthetically by distilling a mixture of salicylic acid and methyl alcohol

Description Methyl salicylate is a colorless, yellowish, or reddish liquid ... Consult the U.S Pharma-

... ethyl salicylate. Oils from natural sources contain small quantities of other constituents, those from gaultheria being discussed above

Uses and Dose.—Methyl salicylate is an antiseptic, an antirheumatic and a flavor. Average dose, 0.75 cc.

Statice or Marsh Rosemary (U. S. P. 1820 to 1882) is the root of *Statice Limonium* Linné, var. *caroliniana* Gray (*Limonium carolinianum* (Walt.) Britton (Fam. *Plumbaginaceæ*). The plant is perennial, acaulescent, preferring salty marshes in southern and western Europe.

The root is fleshy, several headed, branching, deep brownish purple externally

lig]

dry

The drug has been used orally as a hemostatic, an antidysenteric, and as a gargle for ulcerated throat.

SAPOTACEÆ, OR GUTTA PERCHA FAMILY

This is a family of about 40 genera and 600 species of tropical trees and shrubs. The leaves are alternate and evergreen, the flowers are regular and bisexual and occur in the axils of the leaves and the fruits are berries. The plants are especially characterized by the presence of laticiferous sacs, which occur in rows and are distributed in the pith and cortex and accompany the vascular bundles throughout the veins of the leaves. The latex is composed of irregular doubly refracting, amorphous masses of caoutchouc, which when collected and dried furnishes the gutta percha of commerce. To this family also belongs *Achras sapota*, known as the sapodilla tree or "bully-tree," which is indigenous to tropical America and furnishes the sapodilla plum. The latter resembles a russet apple in color and size, and possesses a milky, acrid juice which disappears when the fruit matures. The fruit then develops a sweet taste and becomes edible. The seeds of the sapodilla are sometimes used in medicine, and the latex obtained from the tree is used in the manufacture of a chewing gum.

Gutta Percha, Gutta Pertscha or Gummi Plasticum (U. S. P. 1863 to 1894; N. F. 1916 to 1926) is the purified, coagulated, milky exudate of several species of *Palaquim* and of *Payena*, evergreen trees indigenous to Indo-China and the East Indies Usually the tree is felled and circular incisions about 20 cm. apart are made through the bark the whole length of the trunk; the milky juice slowly exudes, hardens on exposure and is collected. The yield per tree is 3 to 5 kg and may attain 10 kg. The hard exudate is softened in hot water, kneaded, and grosser impurities removed. It is shipped in large blocks weighing about 20 kg ... table sizes;

P ... er,

it is ... m-

becoming plastic at 65° C., very soft and capable of ... perature of boiling water, and on cooling assumes its original form. Externally it is yellowish, grayish brown or dark brown, porous, somewhat fibrous and may be readily cut with a knife; internally it is a grayish white to reddish yellow, frequently with reddish brown streaks of darker colored material; odor slight and somewhat unpleasant.

Gutta percha is usually preserved under water, as when exposed to the air it becomes brittle. It is insoluble in water, cold alcohol, dilute acids and dilute solutions of the alkalis. About 90 per cent is soluble in chloroform, carbon ... ether or oil of turpentine. It is partly ... cooling and evapor- ... ly dissolves it. ... hous hydrocarbon,

gutta, which is soluble in chloroform, ether, petroleum ether, paraffin oil, fixed and volatile oils Two oxidat
viz., (*a*) alban, from 4 to 16 per cer
alcohol; (*b*) fluavil, from 4 to 6 per
cold alcohol. Total ash, from 0 6 t

Gutta percha is a protective, used for external applications. It is used in dentistry as a temporary filling for cavities.

Chicle or Sapodilla Gum is the dried latex of *Achras sapota*, a tall evergreen tree cultivated in tropical America The trunk of the tree is tapped and the dried latex scraped off and exported as crude chicle This is washed with alkali and after subsequent neutralizing and washing forms the base used in the manufacture of chewing gum

Balata is the dried latex obtained from *Mimusops balata*, a tree indigenous to the West Indies and South America. Balata possess the general properties of chicle

Diospy
ros virgi
States.
ber whil
as an astringent Average dose, 2 gm The ripe fruit contains malic acid and sugar and is edible It is used in bread and cakes, and is fermented to form a beer

STYRACACEÆ, OR STYRAX FAMILY

This is a small family of 8 genera and 120 species of trees and shrubs, mostly indigenous to tropical South America, a few representatives being found in the southern United States The leaves are mostly simple and alternate, the flowers are regular and either in axillary clusters or racemes and the fruit is either a berry, a drupe or a capsule Very many of the plants contain a benzoic resin. This occurs in lysigenous, intercellular secretory receptacles, which develop in the wood and bark as a result of certain pathological phenomena. Among special histological characters the following are of some importance: The cork originates either in or below the pericycle, the latter usually containing isolated groups of bast fibers. The stomata on the leaves are usually unaccompanied by neighbor cells, although when present they are parallel to the pore. Non-glandular hairs are either stellate or in the form of peltate scales. Glandular hairs are wanting.

BENZOIN

Benzoin or Gum Benjamin (U S. P 1820 to date) is the balsamic resin obtained from *Styrax benzoin* Dryander, known in commerce as Sumatra Benzoin (U. S P 1820 to date), or from *Styrax tonkinensis* (Pierre) Craib et Hartwich, or other species of the Section *Anthostyrax* of the genus *Styrax*, known in commerce as Siam Benzoin (U. S. P. 1905 to date). *Styrax* is the ancient Greek name of storax, the name applied to a sweet-scented gum and to the tree producing it, benzoin is from the Arabic word *ben*, "fragrant," or the Hebrew *ben*, "a branch" and *zoa*, "an exudation," meaning "the juice of the branch," *tonkinensis* is after Tonkin, a state in French Indo-China.

The plants are trees of medium height growing in southeastern Asia

and the East Indies. *S. benzoin* is cultivated throughout Sumatra; *S. tonkinensis* in Siam, north Annam and Tonkin. Benzoin is a pathological product developed by incising the bark. After about two months the exuding balsamic-resin becomes less sticky and hard enough to be collected. In Sumatra the collected resin is pressed into tins lined with linen and then removed in blocks. In Siam the separate tears are scraped from the trees. New incisions are continually made until the trees die. The tree contains no secretory cells, nor does it contain the constituents of the balsamic resin, until it is incised. The bark of the

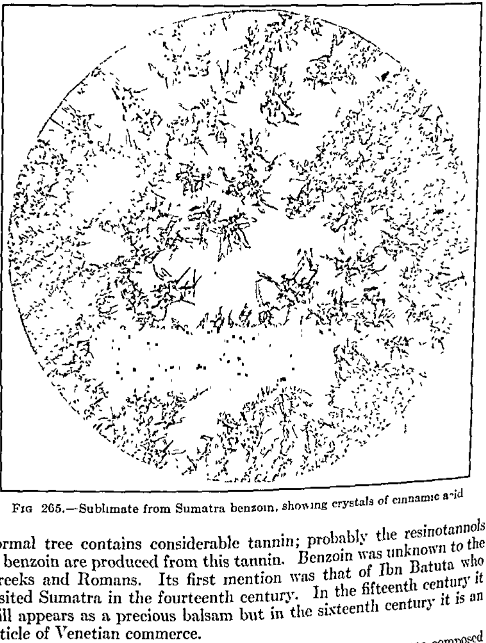


Fig 265.—Sublimate from Sumatra benzoin, showing crystals of cinnamic acid

normal tree contains considerable tannin; probably the resinotannols in benzoin are produced from this tannin. Benzoin was unknown to the Greeks and Romans. Its first mention was that of Ibn Batuta who visited Sumatra in the fourteenth century. In the fifteenth century it still appears as a precious balsam but in the sixteenth century it is an article of Venetian commerce.

Description.—Sumatra benzoin is in blocks or irregular masses composed of tears of variable size imbedded in a translucent or opaque matrix; brittle; the tears internally milky white, becoming soft on warming and gritty when

chewed; the matrix reddish or grayish brown; odor agreeable, balsamic, resembling that of styrax; taste aromatic, resinous

Siam benzoin occurs mostly in separate concavo-convex tears, yellowish brown to rusty brown externally and milky white on the freshly broken surface, brittle but becoming soft upon warming and plastic on chewing, it has a vanilla-like odor.

CONSTITUENTS.—Sumatra benzoin contains about 75 per cent of a resinous substance, *benzoresin, which consists of: (a) an ester of cinnamic acid and* resinotannol (92.6 per cent), and (*b*) an ester of cinnamic acid and benzoresinol. Benzoresin on decomposition yields 30 3 per cent of cinnamic acid; 64 5 per cent of resinotannol, which is soluble in a concentrated sodium salicylate solu-

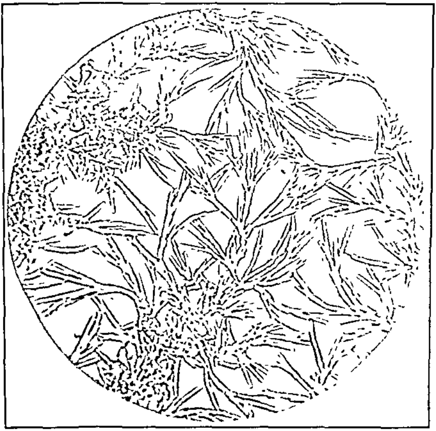


FIG 266.—Sublimate from Siam benzoin showing crystals of benzoic acid.

tion and 5 2 per cent of benzoresinol Sumatra benzoin contains about 17 per cent (10 per cent free) cinnamic acid and about 9 per cent (6 per cent free) benzoic acid, traces of benzaldehyde and benzol, 0 1 to 1 per cent of vanillin; 1 per cent of the phenylpropyl ester of cinnamic acid, 2 to 3 per cent of styracin (cinnamic cinnamate); and 14 to 17 per cent of insoluble matter, consisting chiefly of woody tissues

Siam benzoin consists largely of a resinous substance, siabenzoresin, composed of about 90 per cent of an ester of benzoic acid and siaresinotannol and about 10 per cent of an ester of benzoic acid and benzoresinol Siabenzoresin on saponification yields 38 2 per cent of benzoic acid, 56 7 per cent of siaresinotannol and 5 1 per cent of benzoresinol. Siam benzoin also contains about

12 per cent of free benzoic acid; very little or no cinnamic acid; 0.3 per cent of a neutral aromatic liquid; 0.15 to 1.5 per cent of vanillin; and 1.3 to 3.3 per cent of impurities in the form of woody tissues. **Penang benzoin** has an odor of storax and in composition resembles Siam benzoin. It contains considerable ... **benzoin**, *produced in Sumatra, are a source*

... benzoin yields not less than 75 per cent of alcohol-soluble extractive and not more than 1 per cent of acid-insoluble ash. Siam benzoin contains not more than 1 per cent of foreign organic matter and yields not less than 90 per cent of alcohol-soluble extractive and not more than 0.5 per cent of acid-insoluble ash.

Warm about 0.5 gm. of coarsely powdered benzoin in a test-tube with 10 cc. of potassium permanganate T.S. With Sumatra benzoin the odor of benzaldehyde is evolved, due to the oxidation of cinnamic acid, but with Siam benzoin no benzaldehyde odor is perceptible.

When 2 or 3 drops of sulfuric acid are added to an ethereal solution of benzoin in a porcelain dish, that of Sumatra benzoin produces a deep red-brown coloration while that of Siam benzoin produces a deep purplish red coloration.

Siam benzoin yields not less than 12.5 per cent of residue to warm carbon disulfide. The residue responds to the customary tests for benzoic acid. Benzoin does not show the presence of rosin.

When microsublimed in the usual way Sumatra benzoin yields a sublimate of plates and small rods (cinnamic acid) which strongly polarize light, while Siam benzoin yields a sublimate of needles and rod-shaped crystals (benzoic acid) which do not strongly polarize light.

Uses and Dose. - Benzoin is an antiseptic, a stimulant, an expectorant and a diuretic.

Benzoic Acid ($HC_7H_5O_2$) (U. S. P. 1820 to date) is now mostly a synthetic product, but was first obtained by sublimation from Sumatra benzoin.

It occurs as white crystals, usually as scales or needles. It has a slight odor of benzoin and is volatile at moderate temperatures, and freely so in steam. It is readily soluble in the usual organic solvents, but requires 275 parts of cool water for solution. It readily forms salts with alkalis.

... as a preservative of ... is used as ... diseases, ... externally, as wound dressing. Average dose, 0.5 gm. It is ... ly used in veterinary practice as an expectorant and antipyretic.

Microchemistry of the Balsams

Balsams are resinous substances containing appreciable amounts of benzoic or cinnamic acid. Benzoic acid may be readily sublimed from balsam of Peru, balsam of Tolu and benzoin, while cinnamic acid is readily sublimable from balsam of Peru, balsam of Tolu, storax and Sumatra benzoin. When both acids are present both will be obtained in the sublimate and the following rules are suggested for their differentiation: (1) Benzoic acid usually appears in the sublimate first, the cinnamic acid appearing later; (2) cinnamic acid is more readily soluble in water than benzoic acid, (3) the crystals of cinnamic acid (and its esters) polarize light with a brilliant display of colors while benzoic acid appears gray; (4) the crystals of cinnamic acid are more perfectly formed

than those of benzoic acid; (5) benzoic acid will completely volatilize from the preparation within a few days at room temperature; (6) upon the addition of silver nitrate solution the crystals of cinnamic acid (and its ester) become brown, lose their property of polarizing light and for the most part go into solution (the crystals of benzoic acid also dissolve but appear later as crystals of silver benzoate which polarize light well); (7) if the sublimate of cinnamic acid is subjected to bromine vapors for one-half hour the crystals change to yellowish brown drops while crystals of benzoic acid only partially dissolve and remain colorless. If a drop of carbon disulfide is added to the cinnamic acid slide and covered with a cover glass, plates of dibromcinnamic acid will appear; (8) if the sublimate is treated with a drop of potassium permanganate solution and warmed, benzaldehyde is formed which may be detected by its odor.

OLEACEÆ, OR OLIVE FAMILY

This is a family of about 22 genera and 500 species of trees and shrubs of wide distribution, and well represented in the United States. The leaves are opposite and exstipulate, being either simple or odd-pinnate; the flowers are 2- to 4-parted and are usually in panicles; the fruit is either a samara, drupe or berry; the fibrovascular bundles are of the bicollateral type, the non-glandular hairs are usually peltate; calcium oxalate is secreted in the form of small acicular or prismatic crystals; the tracheæ usually possess simple pores only; in the mesophyll of the leaves, sclerenchymatous fibers or spicular cells are frequently developed.

OLIVE OIL

Olive Oil or **Sweet Oil** (U. S. P. 1820 to date) is the fixed oil obtained from the ripe fruit of *Olea europæa* Linné. The generic name *Olea* is from *oliva*, the Latin name of the olive or from *elaion*, the Greek word meaning oil

The olive tree is a small evergreen tree attaining a great age but seldom exceeds 10 meters in height. It is apparently a native of Palestine and has been widely cultivated in the Mediterranean countries from remote antiquity. It is now also cultivated for its edible fruit and the oil it yields, in southwestern United States and many other subtropical localities. There are a large number of cultivated varieties of the olive, the fruits of which vary widely in size, color when ripe, and in yield of oil.

The olive tree was known in Egypt in the seventeenth century B.C. Its branches have long been used as an emblem of peace. The fruit and its oil were known to the ancient Hebrews and are frequently mentioned in the Old Testament. The olive was introduced into Spain at an early date.

The fruit is a drupe and when ripe, usually is purplish in color. The full grown, but green fruit, as well as the ripe fruit, when pickled in brine, are widely used as a condiment. The olive "stone" or endocarp enclosing the seed has been finely comminuted and used as an adulterant of spices and certain powdered drugs (see Fig 88). Olive wood is highly prized for cabinet work.

Olive oil is of several grades of purity: Virgin oil is obtained by gently pressing the peeled pulp freed from the endocarp; it is rarely exported. First and second grades of edible oil are pressed from crushed pulp, the first grade with less pressure, the second grade from the same pulp with more pressure. Hand-picked olives are used and the oil is obtained promptly before decomposition produces fatty acids. Finally the pulp, mixed with hot water, is pressed again for technical oil; or the pulp is extracted with carbon disulfide to obtain "sulfur" olive oil, of inferior quality. The fallen, decomposed or refuse olives, allowed to ferment, furnish "Tournant Oil," which contains large amounts of free fatty acids, and is used as "turkey-red oil."

Description.—A pale yellow or pale greenish yellow oily liquid; odor slight; characteristic; taste bland, becoming faintly acrid. Olive oil is miscible with ether, carbon disulfide and chloroform; slightly soluble in alcohol. Specific gravity, 0.910 to 0.915 at 25° C. Upon chilling it tends to become cloudy and at 0° C. it usually forms a whitish granular mass.

Constituents.—Olive oil consists chiefly of olein. It also contains linolein, palmitin and arachin, the latter frequently separating when the oil is chilled.

Standards.—Olive oil should be free from cottonseed oil, peanut oil, sesame oil, and tea-seed oil. Consult the U. S. Pharmacopœia for their detection.

Uses and Dose.—Olive oil is a nutrient, a demulcent, a laxative and an emollient. Average dose, 30 cc. It is employed pharmaceutically in the preparation of soaps, plasters, etc., and is widely used as a salad oil.

The leaves of the olive tree were employed many years ago as a remedy in intermittent fever and quite recently attention has again been directed to their therapeutic value as a tonic and febrifuge.

Manna (U. S. P. 1820 to 1936, N. F. 1936 to 1947) is the dried exudation of *Fraxinus ornus* Linné, [illegible] cent of anhydrous extractive soluble in boiling alcoh[illegible] Heaven; *fraxinus* is G[illegible] used for hedges or fen[illegible]

The plant is a small tree indigenous to southern Europe, where it is also cultivated, particularly in Sicily. Manna is obtained from incisions in the bark of trees about eight years old. The exudation hardens on the bark, or is collected in special receptacles. Large Flake manna consists of light-colored pieces [illegible]

brownish, sticky, only slightly crystalline, and very inferior in quality. Flake manna is preferred.

The name manna has been applied to a number of saccharine exudations obtained from different plant species and of varying composition. The manna of the Scriptures may have been an edible lichen used by the Israelites as a food during their journey through the wilderness of Arabia. The manna from the manna ash came into use in Europe during the fifteenth century; before that the manna used came from the East.

Description.—In irregular, 3-sided, more or less elongated pieces, one side being smooth and concave; externally yellowish white; friable, somewhat waxy; internally whitish, porous and crystalline with not less than 40 per cent of brittle or soft, yellowish white or yellowish gray fragments or tears; odor suggestive of maple sugar, taste sweet, slightly bitter and acrid.

The drug contains mannitol, 50 to 60 per cent, fraxin, a green-fluorescent glucosidal principle, in bitter, colorless prisms that are soluble in water and alcohol; mannose, in two forms, mannotriose (a tri-saccharide), 6 to 16 per cent [illegible] 12 to 16 per cent; mucilage; [illegible] Manna is a laxative [illegible]

[illegible] axinus indigenous to [illegible] and [illegible] Europe also yield manna, [illegible] *fyrlacea*) secrete a

The leaves of a number [illegible] manna-like carbohydrate, [illegible]

Mannitol or Mannite (N. F. 1936 to date) is a hexyhydric alcohol, $C_6H_8(OH)_6$, obtained by the reduction of mannose or by isolation from manna. It crystallizes in orthorhombic prisms or in aggregates of fine needles (see Fig 267), it is freely soluble in water and boiling alcohol, but almost insoluble in cold alcohol. For constants and tests of purity, see the National Formulary, Reagent Section. Mannitol is a nutritive, used in bacteriological culture media, and for diabetics; apparently it forms no glucose in the blood.

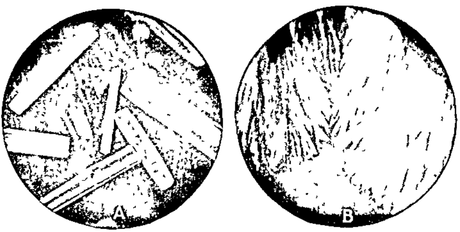


FIG 267 —Orthorhombic crystals of Mannitol (Mannite) obtained from aqueous solutions *A*, large crystals, *B*, feathery aggregates of needles.

Chionanthus or Fringe Tree Bark (N F 1916 to 1947) is the dried bark of the root of *Chionanthus virginicus* Linné *Chionanthus* is from two Greek words, meaning snow and flower, in reference to the snow-white clusters of flowers [illegible] ates and exten- [illegible] e flowers which [illegible] rtain species of [illegible] 9 meters The [illegible] een extensively used in medicine

hard and granular.

The cork consists of tangentially elongated cells with lignified walls, but no stone cells, the cortical parenchyma contains numerous starch grains and a few small prisms, and is associated with a few groups of stone cells and fibers, the inner bark is of small parenchyma cells, sieve tissue, and nearly straight [illegible] and a [illegible] triated, [illegible] at the base of the stem with very thick, porous, lamellated, lignified walls; starch grains simple and compound, 3 to 27 microns in diameter, spheroidal, reniform, plano-convex or polyhedral in shape

Chionanthus yields not less than 35 per cent of anhydrous extractive soluble in 73 per cent alcohol. Chionanthus is an alterative and a tonic Average dose, 2 gm

Fraxinus or White Ash Bark (*N. F. 1916 to 1926*) is the bark of *Fraxinus americana*, a large, beautiful forest tree of the northern United States and Canada. The b[illegible]
of trees from t[illegible]
removed. The [illegible]
in thickness; [illegible]
ous shallow [illegible]
inner surface [illegible]
fracture un[illegible]
aromatic and acrid.
Fra[illegible]
neithe [illegible]
cent, [illegible]

Fraxinus is a bitter tonic and astringent. The bark of the young twigs of *Fraxinus excelsior*, a tree growing in Europe and northern Asia, is used in European countries. It is collected in spring and consists of quills having a thickness of 2 to 3 mm. The b[illegible] what scaly, the inner surface li[illegible] and astringent. It contains a [illegible] principle, fraxinin; and tannic acid from 2 to 3 per cent

LOGANIACEÆ, OR NUX VOMICA FAMILY

This is a family of 33 genera and about 600 species, which are widely distributed. The plants are variable in character, ranging from annual herbs to trees, some being twining and woody vines. The leaves are simple, the flowers regular, having tubular or somewhat campanulate corollas, and the fruit is either a berry or a capsule. The cork is frequently lamellated. There is usually a ring of stone cells in the primary cortex, as in certain species of *Strychnos*. The tracheæ possess simple pores or scalariform perforations, except when the walls are in contact with the cells of the medullary rays, when they develop bordered pores. Calcium oxalate is secreted in all of the usual forms. In the *Loganioideæ* the non-glandular hairs are either unicellular or uniseriate, those in *Strychnos* having a specific value. In *Spigelia* there are developed stellate hairs composed of single united cells, which are inserted upon a multicellular stalk. True glandular hairs, having flattened heads, are only found in *Buddleioideæ*.

NUX VOMICA

Nux Vomica (U. S. P. 1820 to 1947; N. F. 1947 to date) is the dried ripe seed of *Strychnos Nux vomica* Linné. *Strychnos* is the Greek name for a number of poisonous plants; *Nux vomica* is from two Latin words, meaning "a nut that causes vomiting."

The plant is a small tree about 12 meters tall, native to the East Indies and also found in the forests of Ceylon, on the Malabar Coast and in northern Australia. The fruit is a berry with from 3 to 5 seeds, which are freed from the bitter pulp by washing, and dried before exportation. Most of the commercial supplies come from the Madras Presidency. It was introduced into Europe about the Sixteenth century, though it was mainly used for poisoning animals. Its employment in

medicine began about 1640 The natives of India apparently had no knowledge of its medical value.

Description.—See Figure 268 and the National Formulary

Structure and Powder —See Figures 269, 270 and the National Formulary.

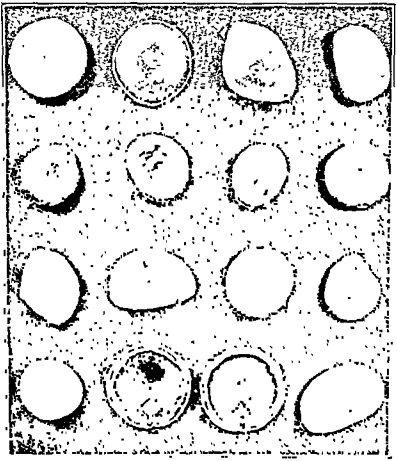


Fig 268 —Nux Vomica orbicular, compressed concavo-convex, sometimes irregularly bent, margin acute or rounded, 10 to 30 mm in diameter, 3 to 5 mm in thickness, externally grayish yellow or grayish green, covered with appressed hairs giving the seed a satiny luster, sometimes with adhering dark-brown fragments of the fruit pulp, hilum, near the center of one side and a more or less distinct ridge resembling a raphé extending from it to the micropyle, very hard when dry, tough when damp, internally whitish, horny; endosperm in two more or less regular concavo-convex halves, embryo small, situated near the micropyle and with two heart-shaped cotyledons, inodorous taste intensely and persistently bitter The two halves of the seed at the middle of the bottom row show the two cotyledons and the caulicle of the embryo lying against the endosperm.

Constituents Natural ash, about 1.5 per cent, soluble in diluted hydrochloric acid; chlorogenic (igasuric) acid, a dibasic acid, crystallizing in needles, [illegible]

of 5 per cent. The alkaloids are prob[illegible]
and the cell wall. Their presence in
tion and in the contents by the use [illegible] dichromate and sulfuric acid
STANDARDS.—Nux Vomica yields not less than 1.15 per cent of strychnine

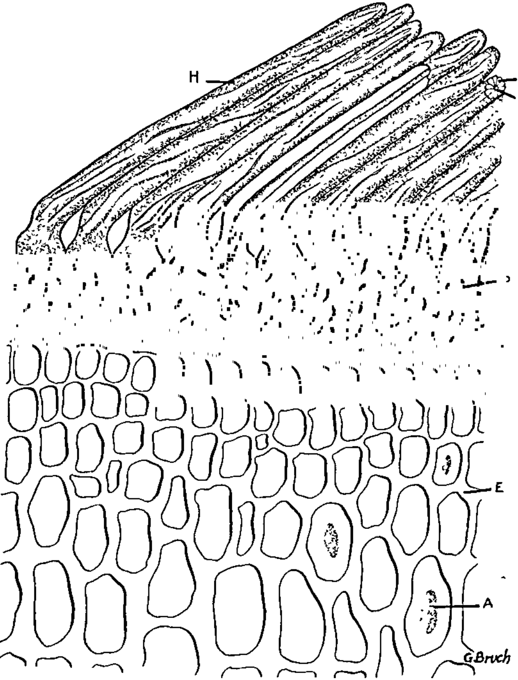


FIG 239.—Nux Vomica transverse section through the outer portion of the seed showing the bent and twisted hairs (*H*) having slit-like pits in the base (*P*) and long curved, very narrow slits in the body of the hair The fifth hair from the left is shown in longitudinal section The seventh hair from the left is shown in transverse section indicating the rod-like thickenings in the wall (*TH*) and the circular lumen (*L*) Beneath the hairs are a thin testa (*T*) composed of collapsed cells, and an endosperm (*E*) of cells with thick cellulose walls and containing aleurone, fixed oil and protoplasm (*A*). (Drawing by Gerston Bruch.)

Uses and Dose.—Nux Vomica has a stimulant action upon the central nervous system, especially so upon the spinal cord. It is a motor excitant, a spinant and a tonic. Average dose, 0.1 gm.

Ignatia or Saint Ignatius Bean (U. S. P. 1863 to 1894; N. F. 1916 to 1936) is the dried ripe seed of *Strychnos Ignatii*, a woody climber of the Philippine Islands. *Ignatii* was given in honor of Ignatius, the founder of the Jesuits who introduced the seed of the plant into Europe from the Philippines in 1699. The seeds are irregular, somewhat oblong or ovoid, pebble-like, 20 to 30 mm. in length; grayish or brownish black, more or less translucent and are nearly

vomica.

tal alkaloids as nux vomica,

ash about 3 per cent, acid-

mica.

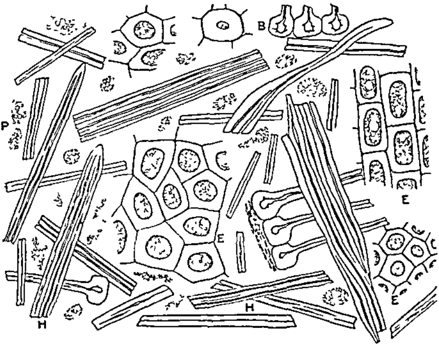


Fig. 270. Nux Vomica. *H*, fragments of lignified hairs of seed coat, *B*, basal portion of hairs, *E*, thick-walled parenchyma cells of endosperm containing one or more oil globules and protoplasm, *P*, isolated protoplasmic substance from endosperm cells.

Strychnine (U. S. P. 1842 to 1926; N. F. 1926 to date)
Strychnine Sulfate (U. S. P. 1863 to date).
Strychnine Nitrate (U. S. P. 1905 to 1912, N. F. 1912 to date).
Strychnine Phosphate (N. F. 1936 to date).

Strychnine Glycerophosphate (*N. F. 1916 to 1926*).
Strychnine Valerate (N. F. 1916 to 1926).

Brucine Sulfate (N. F. 1936 to date).

Strychnine and Brucine are usually obtained from nux vomica, but may be obtained from ignatia. The drug is extracted with dilute sulfuric acid; the solution is concentrated, the alkaloids are precipitated

with lime, separated by means of solvent, and purified by recrystallization. Brucine is far more soluble in water and in alcohol than is strychnine, though strychnine sulfate is somewhat more soluble in these two solvents than is brucine sulfate.

FIG. 271.—Strychnine sulfate: tetragonal crystals from aqueous solution, in ordinary light showing basal and side aspects.

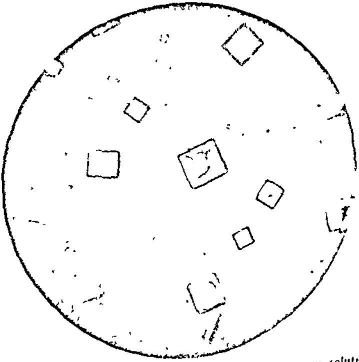


FIG. 272.—Strychnine sulfate: tetragonal crystals from aqueous solution, showing basal aspect in polarized light. Also one large crystal of a second form (orthorhombic?) of strychnine sulfate.

Constants, Solubilities and Tests of Identity and Purity.—Consult the U. S. Pharmacopœia and the National Formulary.

tetrahedra.

Brucine is readily distinguished from strychnine by the deep red color it forms with nitric acid, while strychnine assumes but a pale yellow color. Strych-

less active therapeutically than strychnine upon man, but is sometimes preferred in veterinary treatment.

Uses and Dose.—Strychnine and its salts are stimulants to the central

They are motor excitants,

imine, 1 5 mg.; strychnine

Fig 273.—Brucine sulfate orthorhombic crystals from aqueous solution.

Curare or South American Arrow Poison (U. S P. Reagent 1916 to date) varies in composition among Indian tribes. However, the bark of one or more species of *Strychnos* apparently is always used in its preparation. *Strychnos Castelnæi* Weddell, *S. toxifera* Bentham, *S. Crevauxii* G. Planchon and *Chondodendron tomentosum* Ruiz et Pavon are commonly employed.

The young bark is scraped off the plants, mixed with other items, boiled in water and strained, or extracted by crude percolation with water, then evaporated to a paste over the fire or in the sun. The

of a volatile oil; about 4 per cent of resins; several fatty acids; about 1.5 per cent of total ash and 0.25 per cent of acid-insoluble ash.

root, scammonium root, etc. It may be obtained by microsublimation or by extraction with chloroform. A very dilute chloroformic solution of scopoletin slightly alkalinized with dilute ammonia causes a bluish green fluorescence in the ammoniacal layer.

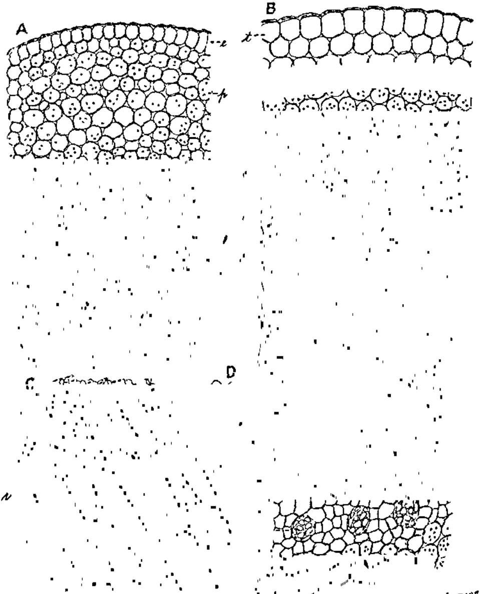


Fig. 276. Pinkroot (*Spigelia marilandica*): *A*, transverse section of root showing ... of central cylinder (*l*), of a 6- to 8-rayed ... substance. *B*, ... which contains a ... Transverse section of rhizome showing epidermis (*t*), the outer ... of cortex containing starch, sieve (*s*), cambium ... r somewhat irregular yellowish brown ... enchyma of pith (*p'*) containing starch. ... rhizome. *D*, Isolated starch grains, which are from 2 to 5 microns in diameter.

Uses and Dose.—Gelsemium has a depressant action upon the central nervous system. It is an antispasmodic, a nervine, a sedative and a mydriatic.

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preserved and kept no longer than two y

oblique, more or less branched, 1 5 to 5 cm. in length, 2 to 5 mm. in diameter; externally dark brown, slightly annulate from scars of bud-scales, the upper portion with stem-scars and stem remnants, under and side portions with

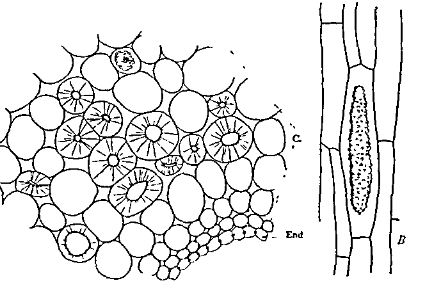


Fig 277.—*Ruellia ciliosa*, the rhizome and roots of which are a common adulterant of Spigelia *A* Transverse section of a secondary root *C*, cortical parenchyma with one cystolith and a number of stone cells with very thick walls and radiating simple pores *End*, endodermis *B*, Longitudinal section of the same root, showing a single cell with an elongated cystolith, the incrustation being of calcium carbonate. (After Holm.)

Powdered spigelia is grayish brown and shows spheroidal or slightly polygonal starch grains, conspicuous fragments containing lignified tracheæ and tracheids, fragments of tracheæ with spiral thickenings relatively few, bast fibers few, very long, non-lignified, occasional fragments of the reddish brown epidermal cells

Spigelia contains a crystalline, volatile alkaloid, spigeline, which somewhat resembles conine and nicotine and which forms precipitates with iodine or Mayer's reagent that are soluble in mineral acids, a bitter, acrid principle, volatile oil, resin, tannin; starch

Spigelia is an anthelmintic

While a very excellent and useful drug, spigelia has fallen into disrepute because of its extensive adulteration For a number of years true spigelia has been substituted by or admixed with **Ruellia**, the rhizome and roots of Tennessee Pinkroot (*Ruellia ciliosa*, Fam *Acanthaceæ*), and with Carolina Pink (*Phlox*

ovata, Fam. *Polemoniaceæ*), both perennial herbs growing in woods and thickets of the southern United States.

Ruellia is easily distinguished from spigelia by large cystolith- the cortical parenchyma cells, by thick, porous and lamellated wa compact zone of porous tracheæ and wood present in the xylem.

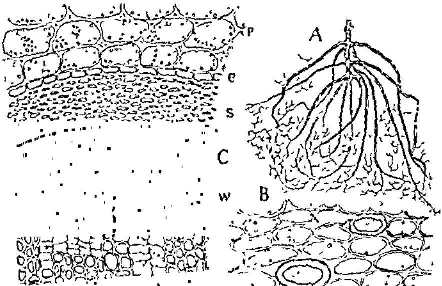


FIG. 278.—*Phlox ovata*. *A*, lower portion of plant showing long roots with numerous rootlets at the ends. *B*, Parenchyma from cortex of rhizome showing two sclerotic cells (*s*). *C*, Cross-section of portion of rhizome showing parenchyma of cortex (*p*) which contains protoplasm and starch grains, endodermis (*e*), phloem (*s*), tracheæ (*t*), wood fibers (*t*), wood parenchyma (*w*), parenchyma of pith containing starch grains and protoplasm (*pa*). *D*, Isolated sclerotic cells from cortex. *E*, Tracheæ having annular and spiral thickenings. *F*, Libriform cells. *G*, Glandular hair from the leaf.

The rhizome of Carolina

GENTIANACEÆ, OR GENTIAN FAMILY

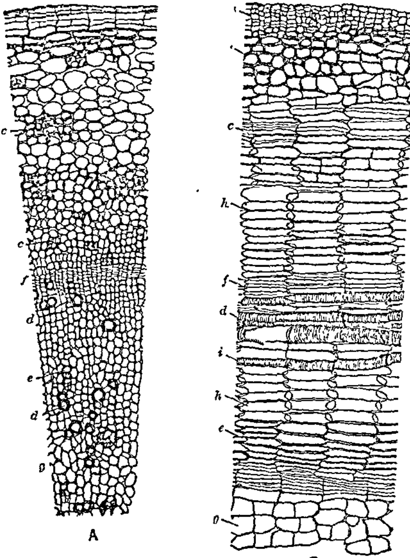
This is a family of 70 genera and about 800 species of herbs, which are most abundant in temperate regions. The leaves are simple and usually opposite; the flowers are regular, and borne in terminal or axillary cymes; and the fruit is a capsule. Strands of interxylary phloem occur in several genera. The medullary rays are very narrow and sometimes entirely wanting. The non-glandular hairs are unicellular. Calcium oxalate crystals are wanting. Bitter principles are invariably present.

FIG. 279.—*Gentiana lutea*, growing in the Royal Botanic Society's Gardens (London) (After Perrédès.)

GENTIAN

Gentian or Gentian Root (U. S. P. 1820 to date) is the dried rhizome and roots of *Gentiana lutea* Linné. Gentian yields not less than 30 per cent of water-soluble extractive and contains not more than 15 per cent of moisture *Gentiana* was named after Gentius, King of Illyria, discoverer of the tonic value of the plant; *lutea*, yellow, refers to the color of the flowers. The plant is a large perennial herb indigenous to central

and southern Europe and Asia Minor. The drug is gathered in the autumn and is cut into pieces of variable length, the more fleshy ones being sliced longitudinally. These are then left in piles and allowed to ferment, after which they are slowly dried. Prepared in this way the internal color of the root changes from white to yellowish brown and a



a, cork of 4 to 6
of thin-walled

considerable amount of the gentiopicrin disappears, probably through enzymic action. The drug is packed in burlap bags, most of the commercial supply coming from Marseilles, Bordeaux, Antwerp, Hamburg and Budapest.

Gentian was known to Pliny and Dioscorides. It was commonly used in medicine during the Middle Ages.

DESCRIPTION.—Nearly cylindrical to irregular pieces, 5 to 40 mm. in diam-
er; externally light brown, annulate above (rhizome portion), longitudinally
inkled below (root portion), and with a few buds, stem- and root-scars;
acture short when dry, tough and flexible when damp; internally yellowish
own, with a distinct dark brown cambium zone

STRUCTURE.—See Figure 280.

POWDER.—Moderate yellowish brown, odor strong and characteristic; taste
rsistently and strongly bitter; fragments of parenchyma tissue with occa-
s
n
;
y
vorotatory needles, soluble in water, less so in alcohol, and may be largely
estroyed by enzymes during curing and drying of the drug. Gentiamarin is
norphous, with a bitter taste Gentiin (gentianin) occurs in microscopic
ellow needles, gives a greenish black color with solutions of ferric salts and

USES AND DOSE.—Gentian is a bitter tonic. Average dose, 1 gm.

Gentiana Catesbæi, Blue Gentian or American Gentian (U. S P. 1820 to
382) is the rhizome and roots of *Gentiana Catesbæi* Elliott, now embracing the
ree common blue gentians in eastern United States, namely· *G. puberula*
Iichaux, *G Saponaria* Linné (*G Cat*
The rhizome and roots are small
cternally, with the distinctive odor
n drug.
an species
Gentiana
, collected
Austria.

Chirata (U S P. 1863 to 1916; N. F. 1916 to 1936) is the dried plant of
wertia Chirayita, an annual herb indigenous to the mountains of northern
ndia The generic name *Suertia* was applied in honor of Emanuel Swert, an
erbalist of the seventeenth century. The plants are collected after the capsules
re fully formed

annin masses.

Chirata contains a bitter glucoside chiratin, which is precipitated by tannin
and yields on hydrolysis two bitter principles, ophelic acid and chiratogenin,
he latter being insoluble in water. Ophelic acid is a brown hydroscopic sub-

stance which is readily soluble in water and in alcohol. The drug also contains resin, tannin and 4 to 8 per cent of ash.

Chirata is a bitter tonic. Other species of *Swertia*, as well as other bitter plants known in India as "chiratta," find their way into the ... e

C ... C

... to its alleged priceless value.

The drug is glabrous, the stem from 15 to 50 cm. long, much branched from the base, but little branched, if at all, from above; slender, sharply angled or narrowly winged, sparsely leafy; leaves opposite, entire, mostly 3-nerved, sessile, those at the base obovate and obtuse, from 2 to 5 cm. in length, their base narrowed and petiole-like, those of above gradually changing to oval, then ovate or even lance-linear, acute; flowers in a terminal compound cyme, rose-colored; calyx from 5 to 7 mm. in length, deeply 5-parted ... sharply angled, lobes linear-attenuate ... twice the length of the calyx, slender; ... its lobes broadly oblong or oval; stamens five, exserted, bright-yellow, their anthers twisted when old; pistil two-carpled. Odor faint but characteristic; taste persistently bitter.

Centaury yields not more than 5 per cent of ash.

Centaury contains a bitter principle; a volatile oil; a resin; erytaurin, a colorless crystalline glucoside; erythrocentaurin, a crystalline tasteless principle, which is colored red on exposure to the light. Also mucilage and wax.

Centaury is a tonic and a febrifuge

Sabbatia or American Centaury (U. S. P. 1820 to 1882) is the overground plant of *Sabbatia angularis*, a biennial herb growing in rich soil and moist meadows throughout the eastern United States and Canada. The drug should be collected at the time of flowering, but the commercial drug frequently is devoid of leaves and flowers and consists of the stems with their capsular fruits.

The stems are very light green, yellowish or pinkish, glabrous, distinctly 4-angled above, each angle with a thin, membranous wing-like ridge of collenchyma; fracture fibrous; pith hollow The leaves are ovate or oblong, cordate and clasping at base, acute apex, entire margin, thin, olive-green, palmately veined. The flowers are in cymes, rose-pink, with 5-parted calyx and corolla, the latter rotate, the segments obovate-elliptical, about 1.5 cm long; stamens 5; ovary and style 1. Fruit is a 2-valved, oblong or ovoid capsule, dark brown and covered with resin. Seeds are numerous, deeply reticulate and very small.

Sabbatia contains a bitter principle, 3.75 per cent; erythrocentaurin; a volatile oil; a greenish resin, mucilage; sugars; ash 2 85 per cent. It is used as a tonic.

Menyanthes, Buckbean or Marsh Trefoil (U. S. P. 1820 to 1842; N. F. 1916 to 1926) is the dried leaf of *Menyanthes trifoliata*, a low perennial herb, having thick, horizontal rhizomes and growing in bogs in the northern United States and from Greenland to Alaska.

The plant is indigenous to Europe and Asia, and the leaves are official in several foreign ... in May or June, at the ... hing petioles 7 to 15 cm. ... , up to 8 cm in length and 4 cm. in breadth, apex obtuse or rounded, base spatulate, margin entire, occasionally somewhat undulate, and bearing hydrathodes, olive-green and glabrous; odor distinct, slight; taste very bitter In the petiole and mesophyll are large intercellular air spaces with large, branching, thick-walled, lignified cells, the branches ... interior of the spaces, thus strengthening the le... he open air-channels. When the leaf is dried ... collapse.

Menyanthes contains a bitter glucoside, menyanthin, yielding on hydrolysis glucose and menyanthol, a mixture of fatty acids, occurring in the form of

Menyanthes is a tonic and a febrifuge.

APOCYNACEÆ, OR DOGBANE FAMILY

This is a large family, comprising 155 genera and over 1000 species of perennial herbs, shrubs and trees. They are very widely distributed, occurring mostly, however, in tropical regions. The leaves are usually opposite, the flowers regular and 5-merous, and the fruits are either follicles or drupes. Non-articulated laticiferous tubes are present in all parts of the plants of this family, developed very early, being present even in the embryo. They usually have thin walls and narrow lumina, and the contents may be a caoutchouc-like substance, so that on the fracture of the bark it may be drawn out into thin threads as in the *Celastraceæ*. The latex may also contain starch grains and distinct nuclei. Secretory cells are also present in the barks of some of the genera, as *Aspidosperma*. Strands of intraxylary phloem occur in the pith Calcium oxalate is secreted in the form of solitary crystals, styloids or rosettes. The non-glandular hairs are either unicellular or uniseriate. Glandular hairs are wanting, except in the leaves of the oleander, in which the hairs consist of several rows of elongated cells, which are covered with a palisade-like secretory epidermis. In the oleander the stomata are situated in deep pits, which are covered with long hairs.

APOCYNUM

Apocynum, Black Indian Hemp, Dog's Bane or Canada-hemp (U. S. P. 1820 to 1916, N. F 1916 to date) consists of the dried rhizome and roots of *Apocynum cannabium* Linné (U S. P. 1831 to 1916; N. F. 1916 to date) or of *Apocynum androsæmifolium* Linné (U. S. P. 1820 to 1882, N. F. 1942 to date) Apocynum possesses a potency such that 0.1 gm. of it is equivalent to not less than 2 U S P. XIII Digitalis Units.

Apocynum is from the Greek meaning dog's bane; *cannabium* is the Greek name for hemp. The plants are perennial herbs growing in fields and thickets in the United States and southern Canada The fibrous bark was long used by the Indians for domestic purposes. Since the days of the earliest settlers, who learned its properties from the Indians, the root of *Apocynum* has been used as a diuretic and a remedy in dropsy.

Description.—Cylindrical, somewhat branched, usually broken into pieces, 3 to 15 mm. in diameter, externally light brown, longitudinally wrinkled and transversely fissured, with a few rootlets or rootlet scars, fracture short; internally, bark light brown, up to 3 mm. in thickness, easily separable from the lemon-yellow, porous, slightly radiate wood.

Stem fragments are distinguished by having a comparatively thin, finely fibrous bark and a hollow center.

Structure.—See Figure 281.

POWDER.—Light yellowish brown; odor saponaceous; taste starchy, bitter, somewhat acrid; starch grains numerous, up to 20 microns in diameter, spheroidal, ellipsoidal, ovoid, pyriform or irregular, with a hyaline central cleft and distinct polarization crosses; numerous, slender, lignified, porous wood fibers associated with tracheæ having simple pits or elliptical bordered pores; stone cells from *A. androsæmifolium* isodiametric or elongated, with strongly lignified thick walls and branching pore canals; few fragments of cork with brown to yellow cell walls; fragments of parenchyma associated with latex cells.

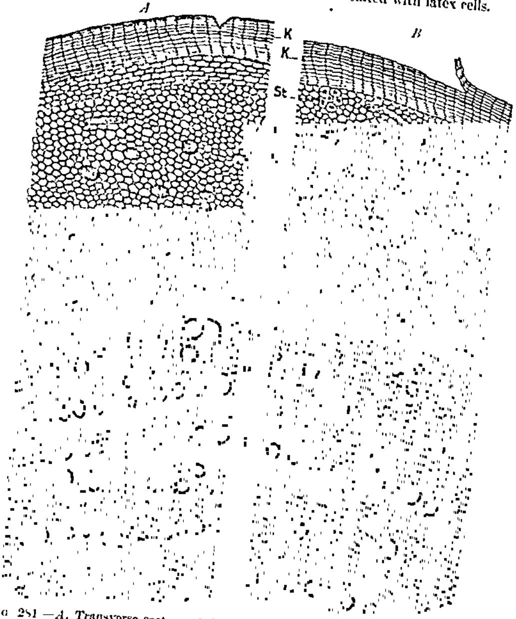


FIG. 281.—*A*, Transverse section of the root of *Apocynum cannabinum* showing cork (*K*), laticiferous tubes (*L*) in the cortex, sieve (*S*), beneath which is the cambium zone, wood fibers (*SF*), tracheæ (*T*), and medullary rays (*MR*). *B*, Transverse section of the root of *Apocynum androsæmifolium* showing in addition groups of stone cells (*St*) in the cortex.

CONSTITUENTS.—Cymarin
genic acid, or of an isomeride
ingly soluble in water but fre
is extremely bitter and represents the cardiac activity of the drug. Apocynin

.2 per cent) occurs in slender colorless prisms with a slight odor of vanillin d apparently is identical with acetovanillin, it is almost inactive pharma-

Uses and Dose —Apocynum belongs to the digitalis series of drugs It is diuretic, an expectorant, a cardiac stimulant, a diaphoretic and an emetic. verage dose, 0 2 gm.

Pharmacologically, *A androsæmifolium* root is not equivalent to *A. cannab-um* root; the latter gives a much stronger cardiac stimulation, while the former s been used as a diuretic and cathartic

The tolerance of the patient to the possible toxic or cumulative action of the ug should be carefully observed and the dosage regulated accordingly.

Fig 282 – Strophanthus seed with awns attached (Photo by Adamson)

STROPHANTHUS

Strophanthus (U. S. P. 1894 to 1936; N. F. 1936 to date) is the dried, ipe seed of *Strophanthus Kombe* Oliver, or of *Strophanthus hispidus*

DeCandolle, deprived of the awns, and possesses a potency, per gram, equivalent to not less than 55 mg. of U. S. P. Reference Ouabain, when assayed by the prescribed method as given in the monograph on Strophanthus Tincture in the National Formulary.

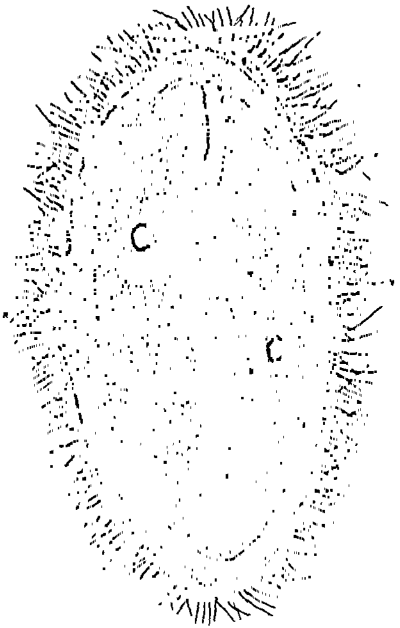


FIG. 253.—Transverse section of strophanthus seed. *SC*, seed coat, with numerous, unicellular hairs (*H*) usually bent, and arising in *S. kombe* seed from the center of the surface of the epidermal cell and in *S. hispidus* seed from near the radial wall; *R*, raphé [illegible]

short straight caulicle and small radicle do not appear in the drawing

Strophanthus is from the Greek meaning "a turn or twist," and "a flower," and refers to the twisted lobes of the corolla; *hispidus* means hairy, referring to the hairy character of the plant; *Kombi* is the native

frican name for the seed. The 30 species of *Strophanthus* native to frica are perennial woody climbers which frequently hang from the ees in festoons. The fruits are gathered when ripe, the mesocarp ripped off and the seeds dried in the endocarp. The awns of the seeds

packing and shipping The seeds of

e largely collected in East Africa near

Brown Strophanthus seeds (*S. hispidus*) come largely from Senegambia and Guinea in western Africa. trophanthus seeds have long been used by the native Africans in the reparation of arrow poisons. These were first observed by Hendelot n western Africa and by Livingstone in East Africa. Early specimens ent to Europe established the powerful cardiac properties of the seeds. trophanthin was isolated in 1865, soon after which the drug was dopted by the medical profession.

nd cymarin

STANDARDS AND TESTS —The endosperm tissue either in the cut seed or in powder form, usually assumes a dark green color when brought into contact with sulfuric acid.

Prismatic crystals of calcium oxalate should be absent in the seed coat (distinction from *Strophanthus courmontii*).

USES AND DOSE —Strophanthus belongs to the digitalis series of drugs and has an action very similar to digitalis It is a heart tonic and a diuretic. Average dose, 0 06 gm

ADULTERANTS AND ALLIED PRODUCTS —The seed of other species of *Strophanthus*, gr

merce For

The seed

Congo Free

S kombe.

The seed of *Kickxia africana*, a tree growing in western tropical Africa, are

Strophanthin (U. S. P 1905 to 1947, N. F. 1947 to date) is a glycoside or a mixture of glycosides obtained from *Strophanthus Kombe* Oliver.

Strophanthin, when assayed as directed in the National Formulary monograph, shall possess a potency per mg. equivalent to 0.5 mg. U. S. P. Ouabain Reference Standard. Strophanthus seeds are defatted with petroleum benzin, after which they are extracted with dilute alcohol. Impurities are removed from the alcoholic solution, after which it is concentrated, *in vacuo* and the strophanthin precipitated. It occurs as a white or yellowish white powder. Consult the National Formulary for its constants and properties.

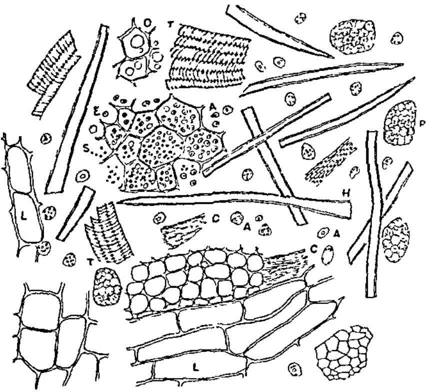


Fig 284.—Strophanthus, Powdered L, surface view of epidermal cells with thickened, lignified walls and bases of hairs H hairs mostly in fragments, but up to 800 microns long

Uses and Dose.—Strophanthin is a cardiac tonic and a diuretic. Average dose 0.5 mg. It is extremely poisonous.

Ouabain or G-Strophanthin (U. S. P. 1942 to date; as Reference Standard U. S. P. 1916 to date) is a glycoside ($C_{29}H_{44}O_{12}.8H_2O$) obtained from the seed of *Strophanthus gratus* (Wall et Hook.) Baillon. The potency of ouabain, assayed biologically, corresponds to the potency of 91 per cent of an equal weight of U. S. P. Ouabain Reference Standard

light yellow or orange taste With 90 per reddish, becoming

violet. Ouabain is prepared by much the same process as strophanthin.

Ouabain occurs as white, odorless crystals or as a crystalline powder. It is extremely poisonous. It is fairly soluble in water and in alcohol. For Constants and Tests of Identity see the U S Pharmacopœia.

)uabain has been used for years as a reference standard in the assay of cardiac-
nulant drugs, largely because it is a pure definite chemical, but also because
;ally, it is used intravenously

(U. S P. 1894 to 1905, 1916
1926) is the dried bark of *Aspidosperma quebracho blanco*, a large tree indige-
us to the western provinces of the Argentine Republic, Chile, Bolivia and
uthern Brazil.
Aspidosperma occurs in irregular chips or in longitudinal pieces; bark from

ghtly aromatic.
The periderm consists of strands of reddish yellow cork, separated by large
oups of stone cells, isolated bast fibers and parenchyma; inner bark has
rch-bearing medullary rays from 1 to 5 cells in width separating narrow
dges composed of parenchyma, large groups of stone cells and an occasional
st fiber, the latter very thick-walled, strongly lignified and surrounded with
ystal fibers.
T'
r
or
n
ec
nvex.
cent, the most impor-
idospermine is colored
changing to cherry-red
loric acid The other
quebrachamine, hypo-
iebrachine.
The drug contains 3 5 per cent of tannic acid; a cholesterin-like body, que-
achol, a sugar, quebrachit; and total ash, of a white or greenish white color,
out 6 4 per cent, with about 0 4 per cent of acid-insoluble ash
Aspidosperma is a heart and respiratory stimulant It is also a diuretic and
antipyretic

ASCLEPIADACEÆ, OR MILKWEED FAMILY

This is a large family of perennial herbs, comprising about 1700
pecies. They are most abundant in North America. The leaves are
pposite or whorled; the flowers usually have a 5-parted corona between
ie corolla and stamens, which is adnate to one or the other, the fruits
re follicles. The anatomical characters resemble very closely those of
ie *Apocynaceæ*. In the pericycle occur either solitary or small groups
f bast fibers. The latter are not found in the secondary cortex. Both
ie glandular and non-glandular hairs are either unicellular or uniseriate.

has long been used as a remedy by the natives of western South America It was introduced into European and North American medicine about 1871. The drug seems to have won greater favor in Europe where it is official in several Pharmacopœias.

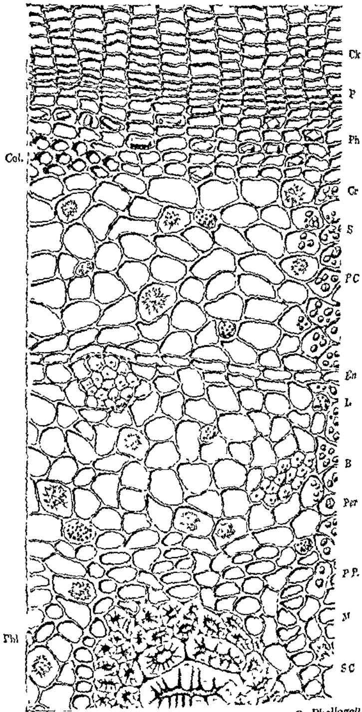


FIG 285 --Condurango (*Marsdenia cundurango*) *Ck*, Cork, *P*, Phellogen, *Ph*, Phelloderm with prisms of calcium oxalate, *Col*, Collenchyma; P C., Primary Cortex, containing rosettes (*cr.*) and starch (*s*) and occasionally latex tubes (*L*); *En*, Endodermis; *Per*, Peri- ... bast fibers (*B*) and occasionally latex ...hloem patches (*P.P.*) com- ...ullary rays (*M*) 2 cells wide.

In single quills or transversely curved pieces, bark from 1 to 6 mm. in thick-

white or light brown, longitudinally striate; fracture short and granular or short fibrous.

chiefly in rosettes, occasionally in single prisms, mostly 10 to 35 microns in
-to 4-compound,
icrons in width;
ameter and filled

droscopic, bitter
pletely soluble in

Condurango is a stomachic bitter, an astringent and an alterative. It is especially useful for diseases of the gastric mucosa. Average dose, 4 gm

Asclepias, Asclepias Tuberosa, Pleurisy Root or Butterfly Weed (U. S P. 1820 to 1905; N. F. 1916 to 1936).

Asclepias Incarnata, Flesh-colored Asclepias or Swamp Milkweed (U. S P. *1820 to 1863, 1873 to 1882)*·

Asclepias Seriaca or Common Milkweed (U. S P 1820 to 1863, 1873 to 1882) are the dried roots, respectively, of *Asclepias tuberosa* Linné, *A. incarnata* Linné, and of *A syriaca* Linné.

drying The rhizomes are horizontal or upright and up to 25 mm. thick; the roots are usually long and those from *A tuberosa* are up to 5 cm in thickness. Externally from gray brown to orange brown, furrowed, with stem remnants and stem scars on the rhizomes, and rootlet scars on the roots Fracture short, tough, bark thin, wood yellow, medullary rays white and finely radiate; pith wanting, except in the rhizome, where it is whitish, with numerous yellow stone cells.

The powder is light brown, the odor slight and the taste starchy, bitter and acrid, calcium oxalate rosettes occur from 15 to 50 microns in diameter, starch grains are 3 to 15 microns in diameter, single and 2- to many-compound, the individual grains spheroidal, plano-convex or irregularly polyhedral, having a large central circular marking or transverse fissure large groups of orange-

colored green with sulfuric acid and pink with nitric acid, changing to purple. Asclepias also contains a volatile oil, several resins, tannic acid; starch, pectin; gum; a fixed oil, and calcium oxalate.

Asclepias is a diaphoretic and expectorant In large doses it is an emetic and a purgative.

33

CONVOLVULACEÆ, OR MORNING GLORY FAMILY

This is a family of about 1100 species, very abundant in the tropics. They are either herbs or shrubs, some being more or less trailing and frequently climbing. The leaves are alternate, the flowers have gamopetalous corollas and the fruits are capsules. Secretory cells, having suberized walls, occur either as isolated cells or arranged in long vertical rows, and contain a colorless or yellowish brown milky substance, which is soluble in alcohol. Latex vessels are rarely found.

The fibrovascular bundles with few exceptions are of the bicollateral type. Calcium oxalate is secreted in the form of small needles, small rods, solitary crystals and rosettes, the rosettes sometimes occurring in the idioblasts of the leaves. The non-glandular hairs usually consist of 2 cells, the stalk cell having a suberized wall. The glandular hairs usually have a unicellular stalk and a multicellular head. In the leaves, the neighbor cells are placed parallel to the pores of the stomata. A very complicated anomalous structure is seen in the fleshy roots of jalap and scammony.

JALAP

Jalap or Jalap Root (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried tuberous root of *Exogonium purga* (Wendoroth) Bentham. Jalap yields not less than 9 per cent of resin which meets the tests of Jalap Resin, page 515, and not more than 0.5 per cent of acid-insoluble ash. *Exogonium* is from the Greek meaning "outside" and "offspring," in allusion to the exserted stamens and pistils; Jalapa is the name of the city in Mexico whence the drug was first obtained. The plant is a perennial twining herb indigenous to the Mexican Andes and cultivated in Mexico, India, and to some extent in the West Indies. The plant possesses thin, horizontal underground runners, from the nodes of which the tuberous roots arise. These are usually dug in the fall, placed in nets and dried over open fires. This latter process accounts for their empyreumatic odor. Our supply comes entirely from Vera Cruz.

The early Spanish explorers who learned the cathartic properties of jalap from the natives introduced it into Europe about 1565. The exact botanical source of jalap, however, remained uncertain until 1829, and it is somewhat questionable whether the roots first introduced into Europe by the Spaniards were those of jalap.

Description.—Fusiform, irregularly ovoid or pyriform, sometimes sliced; ... irregularly
... mm.
... nally
... odor
... cific
distinctive and smol ...
gravity of less than ... u-

Structure and P ...
lary.

Constituents —Resin 8 to 12 per cent; volatile oil; starch; gum and sugar; total ash, 4.33 per cent, acid-insoluble ash, 0 25 per cent. The resin contains a

number of glucosides· ipurganol, a phytosterol glucoside, in colorless needles, and also found in certain *Ipomœa* species; jalapin, a mixture of acidic glucosides, also found in scammony root; also *b*-methyl esculetin, palmitic and stearic acids, etc.

USES AND DOSE.—Jalap is a hydragogue cathartic and a purgative. Average dose, 1 gm.

Jalap Resin (U. S. P. 1860 to 1936; N. F 1936 to date) is prepared by extracting powdered jalap with an alcohol (9)-water (1) mixture. The percolate is concentrated to one-fourth the weight of drug used and is then slowly poured into water with constant stirring. The precipitated resin is washed with hot water, collected and dried.

Jalap Resin occurs in yellowish brown masses or powder It should be free from other resins. Consult the National Formulary for properties and tests. Jalap Resin is a hydragogue cathartic. Average dose, 125 mg

Compound Jalap Powder (U S. P. 1820 to 1936, N F. 1936 to date) consists of powdered jalap (35) and potassium bitartrate (65)

It is very light brown Under the microscope it displays numerous angular color-

crystal fragments); numerous starch grains of jalap, usually single, and from 3 to 35 microns in diameter, occasional fragments of latex cells having yellowish brown contents, or of tracheæ with bordered pores, and rosette aggregates of calcium oxalate 10 to 35 microns in diameter

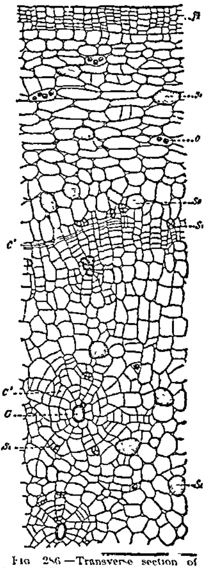


FIG 286.—Transverse section of Jalap *Ph*, cork cells, *Se*, resin-secretory cells, *O*, rosette aggregates of calcium oxalate, *Si*, sieve cells, *G*, tracheæ, C¹, primary cambium, C², secondary cambium (After Meyer)

ALLIED DRUGS.—**Brazilian Jalap** —During World War I several jalap substitutes were offered One of these, known in Brazil as Batata de Purga and Batata Purgante, is the root of *Piptostegia pisonis* It occurs in transverse circular or oval sections, from 3 to 8 cm. in diameter and 0 3 to 0 8 cm in thickness. The cut surface is marked with several concentric rings having a pale grayish brown color and numerous dots of a translucent pale resin It contains about 20 per cent of resin.

Resina drastica comes from Mexico and in a general way resembles Mexican scammony The pieces represent both transverse and longitudinal sections of a root somewhat resembling Brazilian jalap but are of a darker color The cut surface is short-fibrous, due to the projections of the fibrovascular bundles

The amount of resin is 19.2 per cent. It is of a deep lemon-yellow color and gives with ferrous sulfate a dark green color resembling true scammony resin

Turpeth Root or Indian Jalap, is the root of *Operculina turpethum*, a plant growing in the East Indies. It contains a resin consisting chiefly of turpethin and turpethein, a glucosidal, ether-soluble, resinoid substance.

Ipomœa simulans, indigenous to the eastern slope of the Mexican Andes, yields the **Tampico Jalap,** which is more or less uniform in thickness, somewhat tortuous and without any lenticels; it contains about 10 per cent of resin, which is completely soluble in ether and resembles scammonin.

Convolvulus Pandurata, Wild Potato or Wild Jalap (U. S. P. 1820 to 1863) is the tuberous root of *Ipomœa pandurata*, a plant growing in the eastern and southern United States. It has a thick root up to 30 cm. long, contracted to a thin rhizome branch.

The root yields about 1.5 per cent of resin, which consists of two glucosides, and is powerfully cathartic. *It has been replaced by other drugs.*

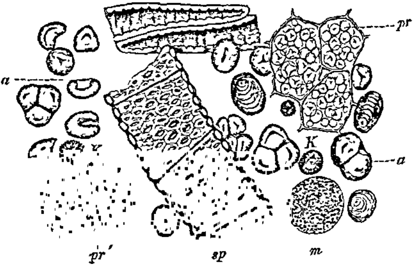


FIG 287.—Powdered Jalap light brown; crystals of calcium oxalate in rosettes (*K*) *10 to 35 microns in diameter*, *starch grains* (*a*) ellipsoidal and ovoid, with somewhat excentral lamellæ, from 3 to 35 microns, 1- *to 3-compound* and in some cases *more or* less swollen (*pr*), resin secretory cells (*m*) yellowish brown; tracheæ (*sp*) short, wide with simple or bordered pores, sclerenchymatous fibers few, with simple pores Tubers deficient in resin are lighter in color and contain more starch and less calcium oxalate (*After Vogl.*)

The aérial stems of the common **Morning Glory** (*Ipomœa purpurea*) contain a volatile oil and 4.8 per cent of a soft resin of which 15 5 per cent is soluble in ether

The roots and stems of *Ipomœa fistulosa* of South America, yield 0.2 per cent of jalapin (orizabin), hexose, wax and tannin.

IPOMEA

Ipomea, Orizaba Jalap or Mexican Scammony (U. S. P. 1926 to 1936; N. F. 1936 to date) is the dried root of *Ipomœa orizabensis* Ledenois. Ipomea yields not less than 15 per cent of resin which meets the tests of Ipomea Resin, page 272 National Formulary, and not more than 3 per cent of acid-insoluble ash. *Ipomœa* is from the Greek, meaning "worm-like," in allusion to the twining stems; *orizabensis* is named after Orizaba,

a city of Mexico, near where much of the drug is gathered. The plant is a perennial vine, the underground portion consisting of a fusiform root about 60 cm. long. The roots are collected, sliced, and dried in the sun.

Ipomea resin is more soluble in ether than that of jalap and more closely resembles that from Levant scammony, of which it was a common adulterant. On account of the ever-increasing scarcity of the latter, Mexican scammony finally replaced it in the United States.

DESCRIPTION.—Flat, transverse segments, varying from 2 to 12 cm. in diameter and from 1 to 5.5 cm. in thickness; externally light to dark brown, very deeply wrinkled; fracture tough, fibrous, inner surface light brown, cut surface showing concentric rings with protruding, lighter-colored fibrovascular bundles.

STRUCTURE.—A thin cork of brownish, thin-walled, narrow, tabular cells, a broad cortical layer of thick-walled, tangentially elongated, starchy paren- [illegible] cular bundles and broad [illegible] and latex cells; the suc- [illegible] one; phloem narrow, in [illegible] lem wedges; resin-latex cells numerous throughout the parenchyma of cortex and wood cylinder, and containing a [illegible]

POWDER.—[illegible] what aromati[illegible] microns in di[illegible]

[illegible]

glycoside soluble in alcohol), and ipurganol (a phytosterol glycoside soluble in petroleum benzin), all of which are found, but in much different proportions in jalap resin.

USES AND DOSE.—Mexican scammony root is a hydragogue cathartic. Average dose, 1 gm.

Ipomea Resin (U. S. P. 1926 to 1936; N. F. 1936 to date) is prepared by extracting powdered ipomea with an alcohol (9) water (1) mixture. The percolate is concentrated to the consistency of a syrup and then poured with constant stirring into twice its volume of hot water. The precipitated resin is washed and dried. Ipomea Resin should be free from other resins and from aloin. Consult the National Formulary for properties and tests. Ipomea Resin is a hydragogue cathartic. Average dose, 0.2 gm.

SCAMMONY

Scammony or Scammonium (U. S. P. 1820 to 1916).

[illegible]

Scammony or Levant Scammony is the gum-resin obtained by incising the living root, which may attain a thickness of 5 cm. and a length of a meter. The earth is partly removed, the root crown cut off and incisions made in the root; the milky exudation is collected in shells and allowed to dry, forming

circular cakes perhaps 10 cm. in diameter and about 1 cm. in thickness. I color is brownish-black, often dusty gray externally; brittle, porous, lust when freshly broken and translucent in thin fragments; odor peculiar, che like; taste slightly acrid. At least 70 per cent of scammony is soluble in eth

Fig. 288.—Scammony Root; Levant Scammony (*Convolvulus scammonia*) in [illegible] pieces (left), and Mexican Scammony (*Ipomœa orizabensis*) in transverse slices (right). (Photo of the commercial drugs.)

[illegible] but very litt [illegible] as long [illegible] of [illegible] cheap [illegible] grossly adulterated with inorganic substances, etc. It has now practically disappeared from American commerce, being replaced with ipomea resin, which rather closely resembles the genuine scammony.

and dried. In Great Britain and Europe, scammony resin was generally prepared from the dried Scammony Root. The ground root was extracted by

U. S. P. IX (1916), but monographs for scammony root and scammony resin prepared from the root were continued for one decade, until 1926, then deleted. The yield of scammony resin from the dried root was from 4 to 18 per cent,

It does not form an emulsion when triturated with water (*distinction from scammony gum-resin*) It is free from *guaiac* and *rosin*

Scammony resin consists largely of scammonin, which is probably identical with the ether-soluble resin from jalap and from ipomea.

Scammony Root, Scammony and Scammony Resin are each a hydragogue cathartic. Average dose of the root, 1 gm ; of scammony, 0.4 gm.; of scammony resin, 0.2 gm.

Montpellier Scammony is the natural exudation of *Marsdenia erecta* (Fam. *Asclepiadaceæ*), a plant indigenous to southern Europe. It contains 50 to 60 per cent of starch, 10 to 21 per cent of resin and yields 11 to 18 per cent of ash.

HYDROPHYLLACEÆ, OR WATERLEAF FAMILY

This is a family of about 17 genera and 170 species of herbs and shrubs, mostly indigenous to western North America. The leaves are opposite, the flowers are regular and 5-merous, and the fruits are capsular. From the supposition that in the springtime the leaves of the plants were filled with water, the family received its name. There is no special anatomical structure on which it would seem that this might be based. The leaves differ very little in structure from those of other plants. They are bifacial and the stomata usually occur only on the lower surface, being surrounded by an indefinite number of ordinary epidermal cells. The non-glandular hairs are usually unicellular, rarely uniseriate, occasionally encrusted with calcium carbonate, or may contain a cystolith-like body. Glandular hairs are widely distributed and are of a number of distinct types.

ERIODICTYON

Eriodictyon or Yerba Santa (U. S. P. 1894 to 1905, 1916 to 1947; N. F. 1947 to date) is the dried leaf of *Eriodictyon californicum* (Hooker et Arnott) Torrey. *Eriodictyon* is from the Greek, meaning woolly, in allusion to the hairy leaves. The plant is an evergreen shrub indigenous to the mountains of California and northern Mexico. The drug is gathered in Lake County, and has long been employed by the Indians of California. It was introduced into medicine in 1875 through the efforts of Dr. Bundy.

DESCRIPTION.—Usually *in fragments; the unbroken leaf lanceolate, 5 to 15* cm. in length, 1 to 3 cm. in breadth; *apex acute; base slightly tapering into the* petiole; margin unevenly serrate or crenate-dentate; upper surface weak brown to *moderate olive brown, glabrous,* resinous; under surface yellowish brown to weak greenish *yellow; reticulate,* minutely tomentose between the reticulations, midrib light yellow, prominent; petiole 5 to 10 mm. in length; *texture coriaceous, brittle.*

STRUCTURE.—Cells of upper epidermis somewhat papillose, the cuticle deeply *striated; deep-seated,* resinous glandular hairs which resemble those of the *Labiatæ,* palisade cells *very narrow, from 2 to 6 rows deep,* containing numerous chloroplastids; cells of loose mesophyll very few; fibrovascular tissues not *strongly* developed except in the midrib and more prominent veins, lower *epidermal* cells having undulate, polygonal walls; in addition to the glandular *hairs there occur* numerous 1-celled, much contorted, thick-walled, non-glandular hairs.

Stems usually show a subepidermal cork, the cells having wide lumina and thin walls; primary cortex of 10 to 20 rows of more or less rounded parenchyma cells; pericycle consisting of a nearly closed ring of bast fibers, phloem in a narrow zone outside the xylem wedges; the latter consisting of tracheæ, having narrow lumina and marked by spiral thickenings and simple pores, and associated with lignified wood fibers having bordered pores; medullary rays 1 cell in width; pith very large.

POWDER.—Yellow; odor aromatic; taste balsamic and bitter, becoming sweetish and slightly acrid; non-glandular hairs numerous, unicellular, much contorted and up to 250 microns in length; glandular hairs having a one-celled stalk and a 6- to 9-celled glandular head up to 120 microns in diameter; fragments of stems with tracheæ and lignified wood fibers; parenchyma cells from pith with thick, [illegible]

CONSTITUENTS [illegible] ... inic acid; formic acid; butyric a[illegible] ... riodictyol, 0.019 per cent, in g[illegible] ... 0.009 per cent, (homoeriodicty[illegible] ... oil, and gum [illegible]

STANDARDS.—Eriodictyon contains not more than 5 per cent of [illegible] and not more [illegible]

USES AND D[illegible] ... It is used also to disguise the [illegible] ... Average dose, 1 gm.

BORAGINACEÆ, OR BORAGE FAMILY

This is a family of about 1550 species which are especially abundant in the Mediterranean region and extend into central Europe and Asia. The plants are mostly herbaceous, rough and hairy. The leaves are generally alternate and the inflorescence is one-sided (dorsi-ventral). The family is characterized by both glandular and non-glandular hairs. Of special importance are the unicellular cystolith-hairs (bristle hairs). Calcium oxalate occurs in the form of prisms, rosettes and microcrystals.

Anchusæ Tinctoriæ Radix [illegible] (U. S. P. 1831 to 1842) is the dried root of *Alkanna tinct*[illegible] to southeastern Europe and Asiatic Turkey [illegible] ciple.

The root is fusiform, simple, 3 [illegible] in diameter; externally deep reddish purple, [illegible] ed, deeply furrowed, the outer layers readily separating [illegible] the crown being frequently several-headed and consisting of the bases of the leaves which

, wood yellowish brown;

churn) 5 to 6 per cent,
oluble in alcohol, chloroform, ether and oils The solutions in alkalis are of a deep blue color, changing to red on the addition of acids. Gawalowski separated alkannin into two acids: (a) alkanic acid, soluble in ether and alcohol and turning blue with alkalis, (b) anchuric acid, soluble in benzene and turning green with alkalis. Alkanet

color It equal to alkanet n for true alkanet.

is the hairy leaves or herb of *Cynoglossum officinale*. It contains an alkaloid possessing a paralyzing effect on the central motor system It has been used as a sedative and demulcent

VERBENACEÆ, OR VERVAIN FAMILY

This is a family of about 760 species of shrubs or trees, distributed in the tropics and sparingly represented in the cooler regions The leaves are opposite or verticillate; the flowers are irregular, having a bilabiate or irregular corolla and didynamous stamens; the fruits are either drupe-like or somewhat capsular, consisting of 2 to 4 nutlets. The stems are not infrequently quadrangular in section. The tracheæ and wood fibers usually have simple pores The stomata are surrounded by a number of ordinary epidermal cells, occasionally they possess 2 subsidiary cells which are distributed transversely to the pore. Calcium oxalate occurs in the form of small acicular or prismatic crystals. The glandular hairs have a unicellular or uniseriate stalk, the head being composed of 6 to 8 cells. A number of types of non-glandular hairs occur in the various genera of this family. An anomalous structure is developed in some of the lianes

Verbena or American Blue Vervain (N F 1916 to 1926) is the dried overground portion of *Verbena hastata*, a perennial herb growing in moist meadows
it is gathered at the
fully dried and pre-
one meter or more

Lippia Mexicana, Orosul, Regaliz de Cuba, is the dried leaf of *Lippia dulcis*, a trailing shrub, widely distributed in tropical America. The leaves are gathered at the time of the flowering of the plant and carefully dried.

The leaves when entire are ovate-la[illegible] margin coarsely serrate; olive-green to g[illegible] and veins prominent; petioles from 5 to [illegible] sweetish, terebinthinate and slightly pungent.

The powder has numerous, long-pointed, unicellular, thick-walled hairs up to 300 microns in length, each containing a cystolith at the base; glandular hairs with short stalks and a 6- to 8-celle[illegible] diameter and with nearly colorless conte[illegible] stomata elliptical, under 35 microns in [illegible] transverse to the pore.

The drug contains a volatile oil containing a camphor, lippiol; tannic acid, colored greenish with ferric salts; and a yellow coloring principle resembling quercetin. The drug is a demulcent and an expectorant.

Lippia Scaberrima, an aromatic drug of South Africa, is reputed to possess remarkable hemostatic properties. The drug contains about 0.25 per cent of [illegible] crystalline substances [illegible]

[illegible] parts of the bark of [illegible] both [illegible] The [illegible] lands [illegible] quills up to 3 mm. in thickness; outer surface brownish with numerous prominent, irregular longitudinal ridges, some of which are of a pale yellow color, giving [illegible] hard and short. The root is in [illegible] surface light yellowish brown [illegible] lly exfoliated; numerous root-scars or root remains along one surface; internally very fibrous and tough Taste slight; odor slight.

Powdered tonga is dark brown, and contains spiral or scalariform tracheæ with lignified [illegible] numerous fragments [illegible] asso- [illegible] simple ciated with rectangular medullary ray cells with lignified [illegible] associated with [illegible] the [illegible] han [illegible] hole [illegible] e of structure [illegible] fragments of cork [illegible] which are [illegible] n oxalate in crystal fibers or in roset[illegible]

The total ash yield is about 7 per cent Tonga is claimed to be an anodyne

LABIATÆ, OR MINT FAMILY

This is a large family of herbs and shrubs, comprising 170 genera and about 3000 species and widely distributed. There are about 40 different genera of the *Labiatæ* represented in the United States. They are characterized by having square stems, opposite leaves, bilabiate flowers and small, indehiscent fruits consisting of 4 nutlets. The Labiate plants bear characteristic glandular hairs consisting of a short, unicellular stalk and a glandular head of 6 to 8 cells; in the mature hairs the upper cuticle is raised like a bladder, due to the great accumulation of volatile oil. They are usually found on the under side of the leaf in

depressions in the epidermis and to some extent on the petioles, stems and calyx, but not on the other parts of the flower or the fruit Non-glandular hairs occur in a number of specific forms In the stomata the subsidiary cells lie transverse to the pore. Calcium oxalate is secreted in the forms of small needles or short rods, rarely as rosettes. The tracheæ and wood fibers have simple pores. There is a strong development of subepidermal collenchyma, especially in the angles of the stems and branches A secondary development of the fibrovascular bundles occurs in the older stems of *Thymus.*

VOLATILE OILS

Volatile oils are odoriferous principles found in various parts of certain plants; they evaporate when exposed in the air at ordinary temperatures They may be formed directly by the protoplasm, or through decomposition of a layer of the cell wall (the resinogenous layer), or by the hydrolysis of glucosides Volatile oils usually occur in special secretory containers; these may be modified ordinary cells, more elaborate tubes, intercellular spaces, glandular hairs, or other complex structures Volatile oils, as obnoxious agents to animals, may prevent destruction of the plant, or, as attractive agents to insects, may aid in cross fertilization of the flower

In the Conifers, volatile oils may occur in all of the tissues. In the rose they occur in appreciable quantities only in the petals; in cinnamon only in the bark and the leaves, in the Umbels in the pericarp of the fruit; in the Mint in glandular hairs on the leaves and stems, in the orange, one kind of oil in the petals of the flowers, and another kind in the rind of the fruit.

Volatile oils do not leave a permanent oily mark on paper; they possess characteristic odors; they are characterized by high refractive indices, most of them are optically active and the specific rotation is [illegible] ils are immis-

[illegible] of the plant parts containing the oil, the oily layer separating from the water in the condensed distillate Glucosidic volatile oils (bitter almond oil, mustard oil) are obtained by enzymic action and subsequent distillation. A few volatile oils (lemon, bergamot, etc.) cannot be distilled without decomposition and these are obtained by expression or other mechanical means.

Volatile oils are usually very complex in composition and usually are deteriorated by exposure to heat, light and air. They should be kept in tightly stoppered, well-filled, amber bottles in a cool, dark place.

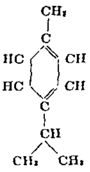
Chemistry of the Volatile Oils.—In only a very few cases, such as oil of mustard and oil of wintergreen, do volatile oils consist of a single chemical compound in a state of comparative purity. In most cases they are mixtures containing compounds of diverse types These compounds may be separated in various ways, i e.: (*a*) low temperatures (thus crystallizing out compounds); (*b*) fractional distillation; (*c*) fractional

crystallization from poor solvents; (*d*) compounds with free acidic groups may be removed with sodium carbonate; (*e*) basic compounds may be removed with hydrochloric acid; (*f*) phenols with sodium hydroxide; (*g*) aldehydes with sodium bisulfite, etc.

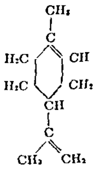
Classification of the volatile oils may be according to their principal chemical constituents. Because of the variable and diverse types of compounds often found in volatile oils, the assignment of an oil to a definite place in such a classification may be difficult.

The classification here given is based upon eight major groups, viz:

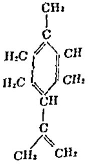
1. **Hydrocarbons.**—Most volatile oils consist largely of terpenes which are isomeric hydrocarbons having the molecular formula $C_{10}H_{16}$. Closely related are the sesquiterpenes, $C_{15}H_{24}$ and the diterpenes, $C_{20}H_{32}$. The most common terpenes are limonene and pinene (page 109), limonene probably being the most widely distributed of the monocyclic terpenes. The monocyclic terpenes are closely related to the aromatic hydrocarbon cymene (p-methyl-isopropyl-benzene) and some authors believe that the naturally occurring monocyclic terpenes are derivatives of cymene. There is also a current theory that terpenes and sesquiterpenes may be produced by the polymerization of two or three molecules of the simple unsaturated hydrocarbon, isoprene, $\begin{matrix}CH_3\\CH_2\end{matrix}\!\!>\!C-CH=CH_2$



Cymene

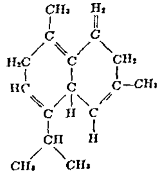


Limonene



Isoprene (2 mols)

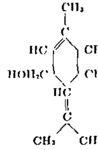
In addition to limonene which occurs in citrus oils and in caraway oil, other important monocyclic terpenes are terpinolene (coriander oil), alpha-terpinene (coriander, origanum and cardamom oils) and alpha-phellandrene (fennel and eucalyptus oils). Pinene (page 109), a dicyclic terpene, is found in many conifer oils, as are other dicyclic terpenes such as sabinene (savin oil) and thujene. Acyclic terpenes are rather rare but ocimene (ocimum oil) and myricene (myrica oil) may be cited as examples. Both have the empirical formula $C_{10}H_{16}$. Cadinene

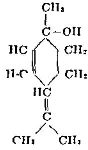


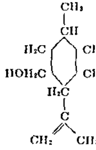
Cadinene

occurring in oil of cubeb, oil of cade and galbanum, is a typical sesquiterpene. Other examples of sesquiterpenes are zingiberene from ginger oil and selinene from celery oil.

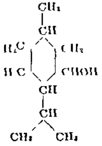
2 **Alcohols.**—Alcohols occurring in volatile oils may be classified into (*a*) acyclic alcohols, (*b*) terpene alcohols and (c) ...
ethyl, isobutyl, i
occur in volatile
in the process of ...
alcohols that appear to be
is broken at one point. Am
and citronellol

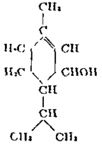

Geraniol

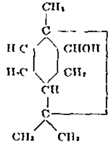

Linalol


Citronellol

Among the more important terpene alcohols are menthol (from peppermint), piperitol (from eucalyptus) and borneol (a dicyclic terpene alcohol from Borneo camphor)


Menthol

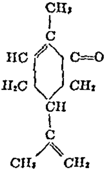

Piperitol


Borneol

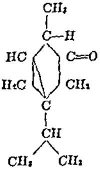
to

...azoin, tolu and
Peru balsams) and cummic aldehyde (cumin seed) which is p-isopropyl-benzaldehyde)

4 **Ketones** Ketones occurring in volatile oils may be divided into (*a*) monocyclic terpene ketones including menthone (pennyroyal, peppermint), carvone (spearmint, caraway), piperitone (eucalyptus) and pulegone (hedeoma), (*b*) dicyclic ketones including thujone (thuja, tansy, wormwood and sage), and camphor, and (*c*) non-terpene ketones such as irone (violet, orris root).

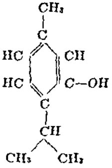


Carvone

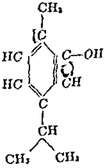


Thujone

5. **Eugonol Phenol** ... phenols occurring in volatile ... other oils: thymol and carvacrol



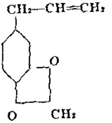
Thymol



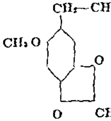
Carvacrol

6. **Phenolic Ethers.**—A number of phenolic ethers occur in volatile oils, of which the following more important examples may be mentioned: anethole from anise and fennel, and safrole from sassafras, camphor oil and Japanese star anise.

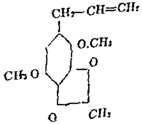
Derivatives of safrole are also often found in volatile oils. Notable among these are myristicin (methoxy safrole) from nutmeg and parsley, and apiole (dimethoxy safrole) from parsley and East Indian dill.



Safrole

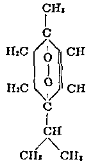


Myristicin

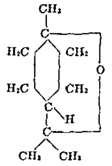


Apiole

7. **Lactones and Oxides.**—Coumarin (page 343), the lactone of coumarinic acid (o-hydroxy-cinnamic acid) occurs widely throughout the Family *Leguminosæ*. Ascaridol (page 234), a dioxide of cymene, is the active constituent of chenopodium oil. Cineol is found in several volatile oils and has been called eucalyptol (page 451) from its occurrence in eucalyptus, and cajuputol (page 452) from its occurrence in cajuput. Coumarin is a lactone, while ascaridol and cineol are oxides.



Ascaridol



Cineol

8. **Esters.**—A wide variety of esters occur in volatile oils, most common among which are the acetates of terpineol, borneol and geraniol It is common practice to age perfumes to permit esterification to take place and thus improve bouquet Other examples of esters in volatile oils are allyl isothiocyanate in oil of mustard and methyl salicylate in oil of wintergreen

Microchemistry of the Volatile Oil Drugs.—Many of the above-named compounds may be isolated from the powdered vegetable drugs containing them by (*a*) microdistillation, (*b*) microsublimation, or (*c*) extraction with a solvent. Some of them may be crystallized directly on the slide (camphor, menthol, thymol) and some may be identified by crystalline compounds obtained with reagents; thus semi-carbazones and phenyl-hydrazones may be made from the aldehydes and ketones directly on the slide; sodium hydroxide forms crystalline compounds with the phenols; dihydrovanillin results from the reaction between vanillin and ferric chloride, and many others Color reactions are also valuable in identifying the micro-isolated compounds.

THE MINTS

Peppermint (U S. P. 1820 to date) consists of the dried leaf and flowering top of *Mentha piperita* Linné. *Mentha* is from the Greek *Mintha*, the name of a nymph mythically metamorphosed into this plant; *piperita* is from the Latin *piper*, pepper, alluding to the aromatic and pungent taste of peppermint.

The plant is a perennial herb indigenous to Europe and naturalized in the northern United States and Canada. It is extensively cultivated in Michigan, Oregon and New York, see Figures 289 and 292. The plants are propagated by rhizome cuttings. When in flower they are cut with a mowing machine, raked into windrows, dried for a few hours in the sun and hauled to the still house. If the plant is to be used as a drug it is carefully dried and preserved. Several varieties of peppermint are cultivated in the United States. Peppermint was described by John Ray in his *Historia Plantarum* (1704). It was extensively cultivated in England as early as 1750.

Description and Structure —See Figures 290 and 291.

Constituents.—Volatile oil, about 1 per cent, resin and tannin.

Standards. Commercial dried peppermint usually consists of the dried herb, though it should contain not more than 2 per cent of stems over 3 mm

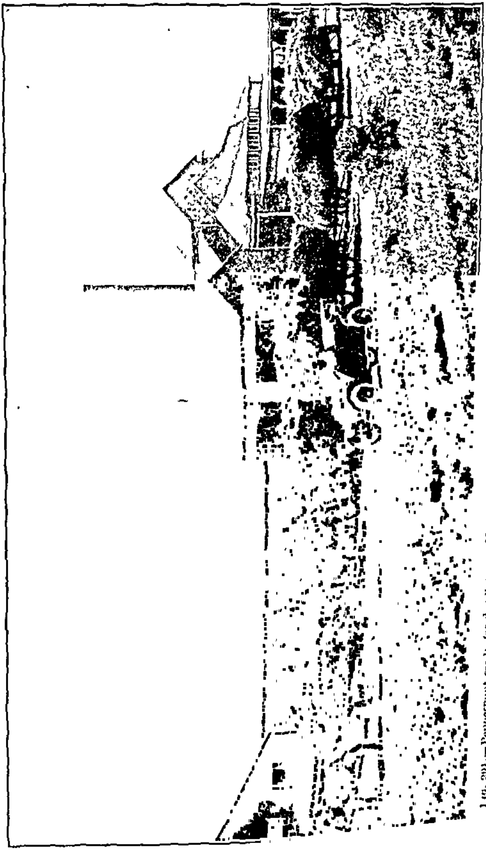


Fig. 201.—Peppermint ready for distillation. Note a steaming load of "spent" mint just from the still at the left. Mentha, Michigan.

Brazil, both areas now producing considerable menthol

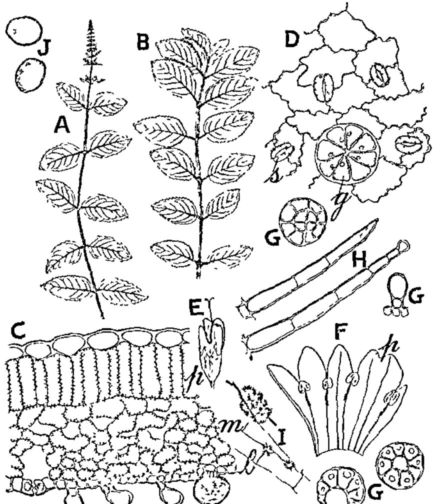


Fig 292.—Peppermint *B*, the quadrangular, purplish green stem, 1 to 3 mm in thickness, and the ovate-lanceolate, opposite leaves, 1 5 to 8 cm in length, with acute apex, acute or rounded base, sharply serrate margin, dark green, nearly glabrous upper surface and glandular pubescent, light green under surface *C*, Transverse section of leaf [illegible]

[illegible] *A*, portion of flower stem, note that the leaves are nearly sessile *E*, Flower with tubular, equally 5-toothed, purplish, glandular-punctate calyx about 2 mm. in length, the outspread corolla (*F*) and 4 erect, adnate included stamens, in peppermint the corolla is regularly 4-lobed, in spearmint the posterior lobe has an extra cleft (*p*). *H*, Non-glandular, uniseriate hairs *G*, Short-stalked, glandular hairs set in depressions in the epidermis. *I*, Sphærites of a carbohydrate found in the corolla and style. *J*, Smooth pollen grains about 35 microns in diameter.

Menthol, $CH_3.C_6H_9.OH.C_3H_7$, (U. S. P. 1894 to date) is an alcohol *obtained from oil of peppermint or other mint oils or prepared synthetically.* Menthol may be levorotatory (*l*-Menthol from natural or synthetic sources) or racemic (*dl*-Menthol, produced synthetically).

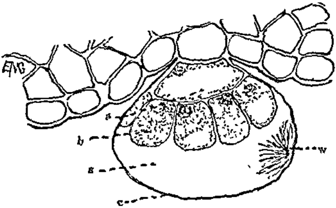


FIG. 293.—Glandular hair from leaf of Peppermint, showing a many-celled gland, *s*, secretion cavity containing Peppermint oil and crystals of Menthol (*w*), *c*, much distended cuticle; *b*, secretion cells; *a*, short stalk. (Drawing by E. N. Gathercoal)

Menthol is usually prepared from Japanese peppermint oil by refrigeration (−22° C.) during which the menthol crystallizes. The liquid portion is poured off, and the crystallized menthol pressed between filter papers and subsequently purified by recrystallization. Synthetic racemic menthol is produced by hydrogenation of thymol.

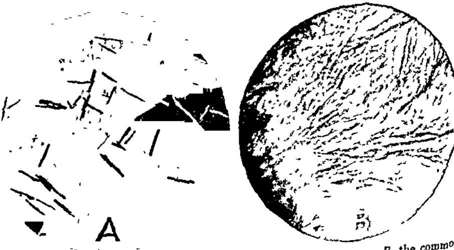


FIG 294.—Menthol *A*, individual crystals obtained by sublimation, *B*, the commonly occurring aggregates of very fine needles.

Menthol occurs in colorless, hexagonal crystals, usually needle-like, having a strong, peppermint-like odor. Menthol should be free from wax, paraffin, inorganic substances and thymol. Consult the U. S Pharmacopœia for constants and tests. Menthol may be readily microsublimed.

USES AND DOSE.—Menthol is mostly employed externally on the skin or mucous membrane as an antiseptic, a local anesthetic, and a stimulant; internally it has a depressant effect on the heart. Average dose 60 mg.

Spearmint (U. S. P. 1820 to date) consists of the dried leaf and top of *Mentha spicata* Linné (*Mentha viridis* Linné). *Spicata* is from the Latin s[illegible]
T[illegible]
t[illegible]
America. Spearmint is extensively cultivated in Michigan and to some extent in Oregon and New York. The plant appears in many of the old Herbals and its mention in early medieval lists demonstrated that it was cultivated in the convent gardens of the ninth century.

Fig 295 — *Mentha spicata* (After Köhler.)

Description — Closely resembling peppermint (see Figs 289 to 293), but the stems are usually more purple, the leaves sessile or nearly so, inflorescence either in slender, interrupted cylindrical spikes or crowded lanceolate spikes and the bracts are somewhat longer (7 to 10 mm) (see Fig. 295); odor and taste aromatic, characteristic, the taste not being followed by a cooling sensation.

Powder.—Green Closely resembling the powder of peppermint except the absence of crystals from the globular heads of the glandular hairs

Constituents.—Volatile oil, about 0.5 per cent, resin and tannin.

STANDARDS.—Spearmint contains not more than 2 per cent of stems over 3 mm. in diameter, or other foreign organic matter.

USES AND DOSE.—Spearmint is a carminative, a stimulant and a nervine Average dose, 4 gm.

Spearmint Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the fresh, overground parts of the flowering plant of *Mentha spicata* Linné (*Mentha viridis* Linné). It yields not less than 50 per cent, by volume, of carvone ($C_{10}H_{14}O$). Most of our supply of spearmint oil is produced in southern Michigan in much the same way as oil of peppermint is produced.

Spearmint Oil is a colorless, yellow or greenish yellow liquid, having the characteristic odor and taste of spearmint. Consult the U. S. Pharmacopœia for constants and tests.

CONSTITUENTS.—Oil of spearmint contains from 45 to 60 per cent of carvone, 6 to 20 per cent of alcohols, 4 to 20 per cent of esters and terpenes, chiefly *l*-limonene and possibly *l*-pinene. The constituent giving the oil its characteristic odor is not known, although it has been attributed to the alcohols and esters present Of the alcohols, dihydrocarveol has been found in the American oil, dihydrocuminic alcohol in the German oil, and linalool in the Russian oil.

The carvone present is *l*-carvone and is optically isomeric (not identical) with the *d*-carvone found in oil of caraway and oil of dill.

USES AND DOSE.—Oil of spearmint is a carminative and a flavor. It is used to a considerable ext [illegible] Average dose 0 1 cc.

ALLIED PRODUCTS [illegible] termined [illegible] plant and consists of [illegible] neol, 5 to 10 per cent of *l*-carv [illegible] garded as

German Spearmint Oil is obtained from *Mentha crispa*, [illegible] a cultural variety of *M. arvensis*. The plant is sparingly naturalized in the United States from Europe. It somewhat resembles *M. piperita*, but is distinguished by its cuspid, irregularly dentate leaves It yields an oil containing carvone

THYME

Thyme or Common Thyme (N. F. 1916 to date) consists of the dried leaves and flowering tops of *Thymus vulgaris* Linné. Thyme yields not less than 1.5 cc. of volatile thyme oil from each 100 gm. of the drug.

Thymus is an ancient Greek name, meaning to sacrifice, in allusion to the sweet odor, *vulgaris*, Latin, means the common or usual kind. The plant is a small evergreen shrub indigenous to Spain and Italy, and extensively cultivated in Germany, France and England for centuries, and also in the United States. The drug is gathered in May or June, carefully dried and exported from Germany and France.

[illegible] and up to 1 mm. [illegible] pubescent, [illegible] ngth, and pith hollow. Leaves lanceolate or ovate-oblong, [illegible] 0 5 to 2 mm in width, apex acute, base tapering into a short petiole; margin entire and revolute; both surfaces grayish weak olive and glandular hairy, the veins prominent Flowers in axillary whorls; calyx 9- to 12-nerved, bilabiate, [illegible] corolla bilabiate and about [illegible] ovary 4-parted and having [illegible] meter, finely tuberculate. [illegible] or uniseriate (2 or 3 cells), [illegible] hooked, with thick, papillose sharp-pointed, straight or somewhat curved or hooked

walls and ...
stalk ...
secreti...
in dian... a short
6- to 8-celled uniseriate ... leaves a glandular punctate ... brown in color and about 150 microns ... an 8- to 12-celled
in length, the walls being thin and which are long-pointed, hairs, appearance. Calyx having
CONSTITUENTS.—A yellowish red the lumina of the lower from 300 to 400 microns
tannin and gum. volatile oil, cells filled with air.
STANDARDS.—Thyme contains from 1 to 2 6 per cent; resin,
1 mm. in diameter and not more than ...
and yields ... cent of its stems over
Av... foreign organic matter,
... carminative and a condiment.

Thyme Oil (U S. P 1863 to 1926, N. F. 1926 to date) is a volatile oil distilled from the flowering plant of *Thymus vulgaris* Linné or *Thymus Zygis* Linné and its variety *gracilis* Boiss. Thyme Oil yields not less than 40 per cent, by volume, of phenols.

It is a colorless, yellow or red ... a pungent ...

to ... characteristic, pleasant odor and
qu... Formulary for its constants.
... a phenol content amounting
linalool and pinene The balance of the ... of thymol, together with small
50 to 70 per cent, is almost entirely carvacrol the oil consists of cymene, borneol,
USES AND DOSE —Oil of thyme is a stimulant, the Spanish oil, which runs between
It is used externally in liniments Average dose, 0 1 cc antiseptic, and antispasmodic.

Thymol, $C_{10}H_{14}O$, (U S P. 1882 to date; in reagents, N. F. 1936 to date) may be obtained from thyme oil (*Thymus vulgaris*), from horsemint oil (*Monarda punctata*), from *Monarda didyma* oil or from ajowan oil (*Carum copticum*) The latter, an umbellifer grown in India is probably ...

The oil ... n
ou... v
hy...
ara...
sub... purified. ... thus liberating the thymol, which is ... thymol being sep-

DESCRIPTION —Large colorless crystals having an aromatic thyme-like odor and a pungent taste Consult the U S Pharmacopœia for properties and tests

Thymol may be readily microsublimed If this process is carried out slowly at a temperature of 35° C , four-sided oblique-angled plates are formed, showing an acute angle of 82 to 85 degrees

USES AND DOSE.—Thymol is an antiseptic, a parasiticide and deodorant It is an anthelmintic, being especially serviceable for hookworm. Average dose: antiseptic, 125 mg , anthelmintic, 2 gm divided into 3 doses

Thymol Iodide (U S. P 1905 to 1947, N F 1947 to date) is a mixture of iodine derivatives of thymol, principally dithymoldiiodide, containing, when dried over sulfuric acid for eighteen hours, not less than 43 per cent of iodine. It occurs as a red-brown or red-yellow bulky powder, insoluble in water, but slightly soluble in alcohol, glycerin, carbon disulfide, paraffin oil, etc It is used as an antiseptic in oil solutions, ointments, suppositories and dusting powders.

Monarda, Horsemint or Mountain Balm (U. S. P. 1820 to 1882) consists of the leaves and tops of *Monarda punctata* Linné. The plant is a perennial herb up to 60 cm. high, indigenous to eastern United States, southward and west to the Mississippi River.

The leaves are up to 5 cm. lon[illegible] lanceolate, acute, toothed and glandular-dotted beneath. The flowers are i[illegible]
summer. The drug has a strongly [illegible]
taste.

Oleum Monardæ or Monarda Oil (U. S. P. 1820 to 1882) is the principal active constituent. The fresh plant is steam distilled, yielding up to 0.5 per cent of oil, which is [illegible]
when below 5° C. [illegible]
some *d*-limonene, [illegible]
used internally as a carminative and diaphoretic; externally in liniments as a stimulant, counterirritant and vesicant. Average dose, 100 mg.

Monarda Didyma, Bee Balm or Oswego Tea, the leaves and flowering tops of *Monarda didyma* Linné; and **Monarda Fistulosa or Wild Bergamot,** the leaves and flowering tops of *Monarda fistulosa* Linné, have both been used in domestic medicine as carminatives and stimulants. They yield volatile oils upon distillation and the oils, especially the one from Monarda Didyma, are rich in thymol.

Thymus Serpyllum, Wild Thyme, Creeping Thyme or Mother-of-Thyme consists of the dried leaves and flowering tops of *Thymus serpyllum*, a low prostrate, creeping perennial herb indigenous to Europe and northern Asia and naturalized in the United States. Commercial supplies are imported from Europe. *Wild thyme yields about 0.5 per cent of a volatile oil containing carvacrol*, thymol and cymene. The drug is employed as an antispasmodic in whooping-cough.

[illegible] tops of [illegible]
Se[illegible]
words, meaning mountain and b[illegible] name, from Mt. Dicte in Crete, on which the plant grew luxuriously. [illegible] are nearly cylindrical, reddish brown, from 0.5 to 2 mm. in diameter. The leaves are broadly elliptical, light greenish gray and *densely tomentose*. The bracts are purplish brown and the corolla dark purple. The plant yields a volatile oil containing about 85 per cent of pulegone.

[illegible] and tops of [illegible] southern [illegible] stems [illegible] petiolate [illegible] h 5 pal- [illegible] h green [illegible] being imbricated bracts and enclosing in fruit the ovoid nutlets, [illegible] elliptical, yellowish brown, about 1 mm. in length and having the epidermal cells modified to papillæ. The plant yields from 2 to 3 per cent of a volatile oil containing from 60 to 85 per cent of carvacrol. The oil, from different sources, *varies in color and in the carvacrol content.*

Fever Basil or Ocimum Viride, the leaves and tops of *Ocimum viride*, a native of West Africa, yields 0.45 per cent of volatile oil which contains 52 per cent of thymol.

LAVENDER

Lavandula or Lavender Flowers (U. S. P. 1820 to 1894) consists of the dried flowers of *Lavandula vera* DeCandolle (*L. Spica* Linné, *L. officinalis* Chaix).

Oleum Lavandulæ or Lavender Oil (U. S. P. 1820 to 1894) is the volatile oil distilled with steam from the fresh flowering herb of *Lavandula vera* DC.

Oleum Lavandulæ Florum, Lavender Oil or Lavender Flower Oil (U. S. P. 1894 to date) is the volatile oil distilled with steam from the fresh flowering tops of *Lavandula officinalis* Chaix et Villars (*Lavandula vera* DeCandolle). It contains not less than 30 per cent of esters calculated as linalyl acetate.

Oil of Spike Lavender or Spike Oil is the volatile oil distilled from *Lavandula Spica* DC. (*L. latifolia* Villers).

The lavender plants are native to Italy, southern France, Spain, and northwestern Africa, cultivated in Europe north to Norway, in England and the United States (southern California) The leaves and flowers were used by the Romans to scent their baths, and the name *Lavandula* refers to the Latin *lavo*, to wash. The flowers and their oil still remain a chief toilet perfume in sachet powders, soap, bath salts, perfumes, etc The flowers produced in the Mediterranean climates, especially on higher elevations, yield finer oil than those grown in colder climates.

Lavender Flowers are bilabiate, from 5 to 8 mm in length, nearly sessile, calyx tubular, about 4 mm in length, obscurely 5-toothed, prominently nerved and dark blue in color, the lower portion being somewhat grayish and hairy, the corolla about 4 mm. in length, dark blue or bluish brown, tubular, two-lipped [illegible] ar hairs, odor, strongly aroma[illegible] t and somewhat bitter. They [illegible]

Lav[illegible] is a colorless or yellow liquid, having the characteristic odor and taste of lavender flowers The oil should be free from alcohol and acetins Consult the U. S. Pharmacopœia for constants and tests.

[illegible] er cent in the French oil, geraniol, lin[illegible] eol, an ester of butyric acid and po[illegible] (a[illegible] t and most intense aroma, b[illegible] m 7 to 11 per [illegible] inctive odor, [illegible] t 35 per cent [illegible] It is exten-[illegible] in cheap perfumery.

The lavender plants tend to hybridize and many of the hybrids produce pleasant and distinctive oils However, so many varieties of lavender oil are confusing.

Uses and Dose.—Oil of lavender is a mild stimulant and a carminative It is employed to perfume and flavor pharmaceutical preparations Average dose, 0.1 cc.

ROSEMARY

Rosemarinus or Rosemary (U. S. P. 1820 to 1894) is the dried leaves of *Rosemarinus officinalis* Linné.

Rosemary Oil (U. S. P. 1820 to date) is the volatile oil distilled with steam from the fresh flowering tops of *Rosemarinus officinalis* Linné. It contains not less than 1.5 per cent of esters calculated as bornyl acetate and not less than 8 per cent of total borneol, free and as esters (see page 536). *Rosemarinus* is from two Latin words, *Ros*, meaning dew, and *marinus*, meaning sea, and refers to its glaucus appearance.

The plant is a branched, bushy, perennial shrub attaining a heig of about 1 meter, growing in France, the Dalmatian Islands, Spain an northern Africa. Although a native of southern Europe, rosemary wa cultivated in English gardens even before the Norman Conquest.

Rosemary Leaves are linear to linear-lanceolate, from 1.5 to 3.5 cm. lon and 2 to 4 mm. broad;
and woolly due to the p
type present; midrib pr
matic, characteristic; t
Rosemary contains from 1 to 2 per cent of volatile oil. Most of the presen day supply of the oil comes from France.

Rosemary Oil is a colorless or pale yellow liquid, having the characterist odor of rosemary, and a warm camphoraceous taste. Consult the U. S. Pharma copœia for constants, etc.

The constituents of oil of rosemary are not completely known. The oil con *tains from 2 to 6 per cent of esters, probably largely bornyl acetate;* from 8 t 20 per cent of total alcohols of which borneol seems to predominate; abou 20 per cent of cineol, and terpenes (probably pinene and camphene).

Uses and Dose.—Oil of rosemary is a stimulant and a carminative. It i also used in liniments as a rubefacient. Average dose, *0.1* cc.

SALVIA

Salvia or Sage (U. S. P. 1842 to 1916; N. F. 1936 to date) is th dried leaf of *Salvia officinalis* Linné It yields not less than 1.25 cc. o *volatile oil from each 100 gm. of drug. Salvia is from* the Latin *salvare* meaning to save, and refers to its use in preserving meats. The plan is a perennial herb attaining the height of about 50 cm., indigenous to *southern Europe, Germany and the United States.* The leaves are gathered when the plant is in flower and carefully dried in the shade. Most of the commercial supply comes from southern Europe.

Description.—Oblong-lanceolate or ovate, 2 to 10 cm. in length, *1 to 2.5* cm. in breadth; apex acute; base rounded or somewhat heart-shaped, frequently ... when lobed; margin crenulate; upper surface ... veins the leaves are *young, the older leaves* ... *nutely* depressed; under surface light grayish green, ... in length, *upper side* reticulate and densely pubescent; petiole 1 to 4.5 cm. in length, upper side grooved, grayish purple; texture velvety, more or less pliable; odor aromatic; *taste aromatic and bitter.*

Structure.—Non-glandular hairs numerous, uniseriate, consisting of *2 to 5* thick-walled cells containing air. Glandular hairs of three types. *(a)* a 2- to ... head, *(b)* a 1-celled stalk and a 2-celled head; ... 8-celled, glandular *head,* containing a brown- ... *and thick-* ... dermis polygonal in surface view and thin ... s having in surface view undulate and thin walls.

Powder.—Dark green; containing numerous characteristic *non-glandular* hairs, also reddish glandular hairs as described above

Constituents.—Volatile oil *0.5 to 2.5 per* cent containing pinene, cineol, *thujone,* and borneol; a bitter principle somewhat resembling *marrubiin;* resin; and tannin, or a principle closely resembling it in its astringency and behavior with ferric salts.

Standards.—Salvia yields not more than 25 per cent of crude fiber, not *more than 10 per cent of total ash and not* more than 1 per cent of acid-insoluble

ash, and contains not more than 10 per cent of the stems of the plant and not more than 2 per cent of other foreign organic matter.

Unground salvia should contain no leaves that are broad, dark green, or with a cordate base (*other Salvia species*), and powdered Salvia should not contain stellate hairs (*Phlomis species*) or an abundance of reticulate tracheæ and crystal-bearing fibers (*Sage stems*).

USES AND DOSE.—Salvia is a stimulant, a carminative and a condiment. Due to the astringent and slightly antiseptic properties of sage, an infusion is used as a gargle Average dose, 4 gm. It is extensively used as a seasoning agent, especially with meats, such as goose, pork and sausage. Sage Oil may be used in place of the dried powdered leaves as a condiment.

FIG 296 —*Salvia officinalis* (After Köhler)

Greek Sage (*Salvia triloba*) has leaves broader and thicker, with short petioles, and with a more woolly surface than official sage leaves

Spanish Sage (*Salvia lavandulæfolia*) has leaves considerably smaller than the official article and possessing relatively long petioles, entire margins and a cordate base The leaves of *Salvia pratensis* are darker in color. These sages and leaves of *Phlomis* species, readily detectable by the stellate hairs, have been found as adulterants of sage

Sclary Sage or Muscatel Sage, the dried leaves of *Salvia Sclarea* Linné, is extensively used in southern Europe. The oil of this sage has an odor of lavender, probably contains linalyl acetate, and is used in perfumery.

CATARIA

Cataria, Catnip, Catnep, or Catmint (U. S. P. 1842 to 1882; N. F. 1916 to date) consists of the dried leaves and flowering tops of *Nepeta Cataria* Linné. *Nepeta* is the ancient Latin name; *cataria* is derived from the Latin *Catus*, meaning cat, and is applied because cats are fond of the plant, eating it and rubbing themselves against it. The plant is a common perennial herb naturalized in the United States from Europe and often growing as a weed.

The leaves and tops are gathered in the late summer when the plant is in bloom, and carefully shade dried. Most of the drug comes from plants cultivated in the United States.

DESCRIPTION.—See Figure 297 and the National Formulary.

POWDER.—Light olive brown to light olive; odor, aromatic and mint-like, taste, bitter, aromatic and pungent; numerous fragments of parenchyma and palisade tissue containing green plastids; non-glandular hairs numerous, 1- to 5-celled, tapering, more or less broken, the basal cells up to 50 microns in diameter; glandular hairs with 1-celled stalk and many-celled secreting head, the latter up to 70 microns in diameter; tracheæ with spiral, reticulate, annular or simple ... 30 microns in diameter; collencl...

CONS... tannin and an oxygenated vo... t 13 per cent of natural ash, stems about 10 per cent and roots about 7.5 per cent. The leaves yield about 1 per cent of acid-insoluble ash, and the stems about 0 5 per cent. The drug yields up to 1 per cent of volatile oil.

STANDARDS.—Catnep contains not more than 5 per cent of its stems over 4 mm. in diameter or other foreign organic matter, and yields not more than 2 per cent of acid-insoluble ash

USES AND DOSE.—Cataria is used as a carminative, a stimulant, a diaphoretic and a tonic. Average dose, 4 gm.

Scutellaria or Skullcap (U. S. P. 1863 to 1916; N. F. 1916 to 1947) is the dried overground portion of *Scutellaria lateriflora* Linné. *Scutellaria* is from the Latin *scutella*, a dish, alluding to the calyx when fruiting; *lateriflora* alludes to the arrangement of the flowers on the stem. ... stem

The plant is a perennial, ... the attaining a height of about ... the

... with surprising interest, and the student is referred to John Uri Lloyd's "Origin and History of Pharmacopœial Vegetable Drugs," where the story is related in a most interesting manner. A certain ... useful in the treatment of ... has been related by ... Pharmacopœia). The ... named Lewis, whose ... r, the name, mad-dog ... has been entirely lost

DESCRIPTION.—Stem quadrangular, 1 to 4 mm. in diameter, yellowish green to purplish red, mostly glabrous below and hairy above. Leaves (Fig. 298) ... surface dark green, gla... 1.5 to 3 cm. in le... 10 mm. in length, ... calyx campanulate; ... m. in length, the ... lipped; stamens 4, ... the upper pair with 2 pollen sacs, the lower

with one; style unequally 2-cleft and ovary deeply 4-parted. Fruit consisting of 4 ellipsoidal, distinctly tuberculate, light brown nutlets about 1 mm. in length, borne on an enlarged torus known as the gynobase, and enclosed by

FIG. 297.—Catnip tops, from 10 to 20 cm. long, much branched or crushed and broken; [illegible]

dilated, limb bilabiate, the upper lip erect and 2-cleft, the lower spreading and 3-cleft, the middle lobe largest, crenulate, stamens 2 pairs ascending under the upper lip, lower pair shorter. *Odor faintly aromatic and mint-like, taste bitter, pungent and aromatic.* (After U. S. Bureau of Plant Industry.)

the persistent bilabiate calyx, the upper part of which becomes helmet-shaped after fertilization, whence the name "Skullcap."

STRUCTURE.—See Figure 298.

POWDER.—Dusky greenish yellow; odor slight; taste bitter; non-glandular hairs long, numerous, 1- to 3-celled, the basal cell being large, broadly cylindrical and the apical cell narrow and with a sharp, frequently recurved summit; glandular hairs with a 1- or 2-celled stalk and large, glandular head, composed

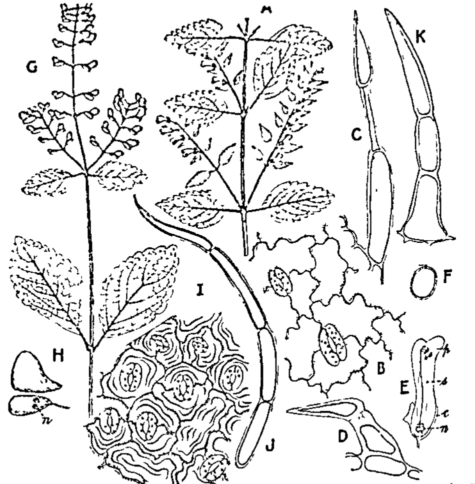


Fig. 298.—Scutellaria lateriflora. A, portion of branch showing the ovate serrate leaves ... stomata ... pilosa). G, Branch showing crenate leaves and helmet-shaped ... I, view of lower ... Capsule after dehiscence showing nutlets (n). *Scutellaria canescens* ... surface of leaf showing numerous broadly elliptical stomata and wavy cuticle. J, K, hairs from the leaf.

of 4 cells divided by vertical walls, indistinct; pollen grains nearly spheroidal or ellipsoidal, smooth and up to 25 microns in diameter; fragments of corolla colored light pink with chloral T.S.; narrow tracheæ with scalariform and reticulate thickenings or bordered pores. In *Scutellaria canescens* the non-glandular hairs are 3- to 5-celled and vary in length from 0.3 to 1 mm.; the glandular hairs have a 4-celled stalk and 8-celled head, are larger and more prominent than in *S. lateriflora*, and the stomata are narrowly elliptical (Fig. 298).

Constituents.—A bitter crystalline glucoside scutellarin, a small quantity of volatile oil, of which little is known. Total ash, about 7.5 per cent, acid-insoluble ash, about 0.5 per cent.

Uses and Dose.—Scutellaria is a tonic, a nervine and an antispasmodic. Average dose, 1 gm.

Western Skullcap (*Scutellaria canescens*), a plant growing west of the Mississippi, furnishes much of the drug on the market. *The plant is more robust than S. lateriflora; the leaves are oblong, petiolate, 10 to 12 cm. in length, 3 to 5 cm. in breadth, very hairy on the under surface, with prominent veins, and crenate-dentate margins; and the flowers are large, blue and in terminal racemes (Fig. 293).*

Allied Plants.—Several species of *Scutellaria* growing in the United States are sometimes substituted for the genuine drug, nearly all of these have the flowers in terminal panicled racemes. **Heart-leaved Skullcap** (*Scutellaria cordifolia*) is densely glandular pubescent, even the corolla being hairy. **Hairy Skullcap** (*S. pilosa*) is pubescent below, with numerous glandular hairs above and the corolla is nearly glabrous, **Hyssop Skullcap** (*S. integrifolia*) has linear entire upper leaves, in **Marsh Skullcap** (*S. galericulata*) the flowers occur in the axils of the nearly sessile, narrow leaves. The **European Skullcap** (*S. altissima*) has broad, ovate, glabrous leaves and terminal panicles of blue flowers.

Marrubium or White Horehound (U. S. P. 1820 to 1916) consists of the dried leaves and flowering tops of *Marrubium vulgare*, a perennial herb indigenous to Europe and Asia, and cultivated in various parts of Europe and the United States, being naturalized in waste places from Texas and Mexico to Maine and Ontario. The stems are quadrangular, yellowish or grayish green, very pubescent, leaves broadly ovate, opposite, 1.5 to 6 cm. in length, apex obtuse; base acute or rounded, margin coarsely crenate, upper surface dark green, pubescent, veins depressed, under surface grayish green, very pubescent, veins prominent, petiole 0.5 to 3 cm. in length. Flowers sessile, in axillary clusters, calyx tubular, about 5 mm. in length, corolla whitish or light brown, about 7 mm. in length, upper lip erect, entire or bifid, stamens 4, included. Nutlets brownish black, ellipsoidal, slightly compressed, about 1.5 mm. in length, nearly smooth. Odor slight, aromatic. Taste aromatic and bitter.

Non-glandular hairs of three types are present: (a) Short, unicellular hairs, (b) long-pointed, unicellular hairs, having papillose walls, and (c) branched or tufted, multicellular hairs, having from 6 to 15 cells radiating from a central stalk. Glandular hairs of two types having either a short or long stalk and a 2- to 8-celled glandular head. Epidermal cells of both surfaces more or less tabular, the walls being but slightly undulate. The powder is dark green, spheroidal, spinose pollen grains, about 25 microns in diameter, are numerous.

Marrubium contains a bitter, somewhat acrid principle, marrubiin, 0.02 to .4 per cent, which forms prismatic crystals and is sparingly soluble in water, several other bitter principles, a volatile oil, a resin, and tannin. The commercial drug consists at times of *Ballota hirsuta*. Marrubium is a stimulant and a tonic, in large doses it is a diuretic and a diaphoretic.

Black Horehound, *Ballota nigra*, an herb of the Old World, naturalized in New England, possesses ovate or lanceolate, dentate-serrate, cordate, hairy leaves and flowers, having a funnel-form calyx, a pale purple corolla shorter than the calyx, anthers exserted beyond the tube of the corolla. Odor disagreeable, hence the name, Fetid Horehound.

Water Horehound, *Lycopus europæus*, possesses ovate-lanceolate, lobed or divided leaves, and the calyx lobes are triangular. It has been used as an astringent, a sedative, a diuretic and a diaphoretic, especially to relieve intermittent fever.

Lycopus or Bugleweed (U. S. P. 1831 to 1882) is the herb of *Lycopus virginicus* Linné, a biennial found in shady, moist places from Canada southward to South Carolina. It grows to a height of 0.5 meter, with a smooth stem, opposite, short-petioled, slender elliptical, toothed, pellucid-punctate leaves, and with axillary clusters of purplish flowers. The drug has a mint-like odor and a bitter,

somewhat aromatic taste. It contains a small percentage of volatile oil and a bitter principle.

It has been used as an astringent and a sedative and it reduces the pulse rate. It is now rarely used in medicine.

Hedeoma or American Pennyroyal (U. S. P. 1831 to 1916) consists of the dried leaves and flowering tops of *Hedeoma pulegioides*, an annual herb indigenous to the eastern and central United States and Canada. Pennyroyal should be collected in July or August and dried.

The stem is quadrangular, 1 to 2 mm. in diameter, light or reddish brown, with numerous spreading hairs. The leaves are elliptical or ovate, opposite, 15 to 35 mm. in length, base
upper surface dark green;
hairy; inflorescence in 6-flowered axillary whorls; calyx tubular,
in length, pubescent; corolla about the size of the calyx, purplish, pubescent; fertile stamens 2, exserted, ascending, the sterile upper pair rarely with anthers Nutlets nearly spheroidal or ovoid, about 0.5 mm. in diameter; odor strongly aromatic; taste aromatic.

hai
or
glandular head; stomata broadly elliptical with a pair of neighbor cells
verse to the pores, the cells frequently containing large sphere-crystals of a carbohydrate. The tracheæ are spiral or with simple and bordered pores and the fibers long, thin-walled, lignified, and with numerous pores. The pollen grains are somewhat spheroidal, about 35 microns in diameter and nearly smooth. Each epidermal cell usually has sphere crystals or an irregular crystalline mass of a carbohydrate.

Pennyroyal contains a volatile oil (about 3 per cent in the dried leaves and 1.3 per cent in the dried stems), a bitter principle and tannin. The volatile oil consists chiefly of the ketone pulegone, which gives the oil its peculiar properties; also
acetic and

Hedeoma is a stimulant and a carminative; also an emmenagogue

Oleum Hedeomæ or Pennyroyal Oil (U. S P. 1831 to 1916) is a powerful but dangerous ecbolic and intestinal irritant. Its use in medicine has practically ceased

European Pennyroyal, *Mentha Pulegium* Linné, a perennial herb found in moist sandy locations in central and southern Europe, yields a volatile oil similar to that from American Pennyroyal and has been substituted for it.

Wild Mint, *Mentha arvensis*, var. *canadensis* Linné, a perennial herb common in wet places in the United States, with ovate-oblong or lanceolate leaves, in the axils of which whorls or globular clusters of flowers arise. The plant has an odor of pennyroyal and yields 1.25 per cent of a volatile oil from which pulegone and thymol or carvacrol have been isolated

New England
odor of
to
pennyroyal.

Oil of Russian Pennyroyal contains pulegone, but the botanical origin is not known.

Marjoram or Sweet Marjoram consists of the dried leaves and flowering tops of *Origanum majorana* (*Majorana hortensis*), an annual herb indigenous to southern Europe, northern Africa and western Asia and extensively cultivated as a pot or seasoning herb.

The leaves (see Fig. 299, *B*) are from 1 to 4 cm in length and 0 6 to 20 mm. in width; both surfac … downy and glandular-hairy. The odor is distinctly … at pungent. … which is a
It yields up to 1 per cent of a … and a large mixture of borneol and camphor It also contains some … percentage of ash, mostly acid-soluble. The leaves of *Coriaria myrtifolia* (Fam.

Coriariaceæ) have been substituted for sweet marjoram These are readily distinguished (see Fig. 299, *A*)

Marjoram is widely used as a condiment and occasionally as a mild stimulant and carminative.

Origanum or Wild Marjoram (U. S P. 1820 to 1863; 1873 to 1894) is the herb of *Origanum vulgare* Linné, a perennial indigenous to Asia, Europe and northern Africa, and introduced into the United States The plants prefer dry soil and are 0 5 to 1 meter high. The leaves are opposite, petiolate, roundish

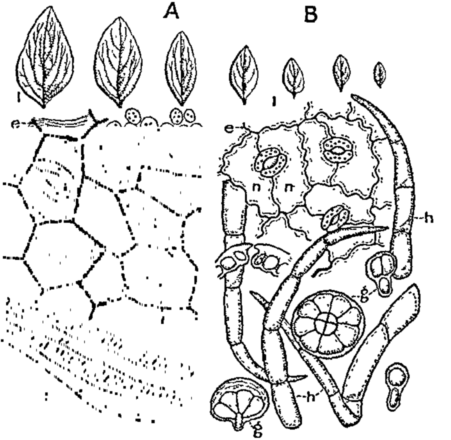


FIG 299 —*A*, *Coriaria* *l*, entire leaves, *e*, surface view of the lower epidermis showing two of the stomata with two neighbor cells which are situated parallel to the pore of the st[illegible]
ne[illegible]
sh[illegible]
st[illegible]

ovat[illegible]
are t[illegible]
bell-[illegible]
The odor of the drug is strongly aromatic, marjoram-like, the taste warm, aromatic and bitter

The herb contains volatile oil, about 2 per cent when recently dried, a little tannin and a bitter principle

Oleum Origani or Origanum Oil (U. S P 1820 to 1863, 1873 to 1882) is pale yellow and limpid, becoming thicker and darker on exposure. It is strongly

aromatic and pungent. It contains carvacrol and a stearoptene. It is often substituted with red oil of thyme.

It has been used as a counterirritant in toothache and neuralgia, in liniments, and internally in dysmenorrhea, colic, and as an emmenagogue. Dose, 0.3 cc.

Melissa, Balm or Lemon Balm (U. S. P. 1842 to 1905) is the dried leaves and tops of *Melissa officinalis* Linné. The plant is indigenous to southern Europe and western Asia and is naturalized and frequently cultivated in the United States and other countries. It attains a height of a meter. The leaves are up to 5 cm. long, broadly ovate, crenate-toothed. The inflorescence is axillary cymules of about 4 flowers each; calyx, bell-shaped, toothed, pubescent; corolla milk-white to pale purple, curved upward, the upper lip notched, the lower 3-lobed. The odor and taste of the drug are mildly aromatic, lemon-like. Balm is used as a pleasant tea. It is mildly diaphoretic.

Collinsonia or Stoneroot, is the dried rhizome and roots of *Collinsonia canadensis* Linné, a perennial herb, and eastern United States. Th the fall and employed in either

The rhizome is horizontal, irregularly branched, from 3 to 15 cm. in length, and 1 to 2 cm in thickness; externally light to dark yellowish brown, roughened from the bud-scales, short conical buds, root bases, stem bases and shallow stem-scars; very hard, tough; internally light yellowish, having a thin bark, a narrow layer of wood and a very large pith; odor slight; taste astringent, slightly pungent The roots are filiform, dark brown, more or less curved and branching toward the ends.

The cork cells have yellowish brown walls; the pith parenchyma has thickened lignified walls; the small fibrovascular bundles are separated by broad medullary rays, the cells laden with starch. The numerous starch grains are mostly single, narrow cylindrical, ellipsoidal, pyriform, fusiform or reniform in shape and from 2 to 25 microns in length. The hardness of the root is due to the large amount of lignified tissue.

Collinsonia contains a saponin-like ... other, partly soluble in alcohol, organic acids; tar ... al ash about 3.25 per cent, with 0 55 per ce

Collinsonia herb contains an acrid volatile oil.

Collinsonin is the resinous extract of Collinsonia prepared by pouring the alcoholic extract of the drug into 3 volumes of water, thus precipitating the resin

Collinsonia is an astringent, a diuretic and a diaphoretic. It is used particularly in genito-urinary affections. Average dose of drug, 2 gm.; of collinsonin, 150 mg. The herb also has been used for similar effects, but is much milder.

SOLANACEÆ, OR NIGHTSHADE FAMILY

The plants are of varied form, most abundant in tropical regions, and the family comprises 85 genera and about 1800 species. The leaves are usually alternate; the flowers are mostly regular, excepting in *Hyoscyamus;* the anthers are connivent, the pollen sacs being apically or longitudinally dehiscent; and the fruits are superior berries or capsules. The plants are usually malodorous. They furnish a number of important economic products, including potato, tomato, egg plant and tobacco as well as a number of drugs.

The plants possess no special internal secretory tissues; bast fibers are usually wanting, except possibly in *Atropa Belladonna.* The medullary rays are generally narrow, and wood parenchyma is scantily developed. In *Atropa, Datura, Solanum* and *Scopolia,* an intraxylary

phloem is frequently developed, in which sclerenchymatous fibers may occur. The walls of the pith cells are usually lignified in *Duboisia* and some other genera. Calcium oxalate is in the form of solitary crystals, rosettes or sphenoidal microcrystals. Both glandular and non-glandular hairs occur in a great variety of forms

Fig. 300.—Atropa belladonna showing the alternate, petiolate, ovate, entire leaves, in the axils of which are the solitary fruits or flowers with large leafy bracts

BELLADONNA

Belladonna Leaf or Deadly Nightshade Leaf (U. S. P. 1820 to date) consists of the dried leaf and flowering or fruiting top with branches of *Atropa Belladonna* Linné, yielding not less than 0.3 per cent of the alkaloids of Belladonna Leaf

Belladonna Root or Deadly Nightshade Root (U. S. P. 1863 to 1947; N. F. 1947 to date) is the dried root of *Atropa Belladonna* Linné, yielding not less than 0.45 per cent of the alkaloids of Belladonna Root

Atropa is from *Atropos,* meaning inflexible, the name of the Greek Fate who cuts the thread of life, and probably alludes to the poisonous character of the drug. *Belladonna* is from the Italian, *bella,* beautiful, and *donna,* lady; the juice of the berry placed in the eyes causes dilation of the pupils, thus giving a striking appearance.

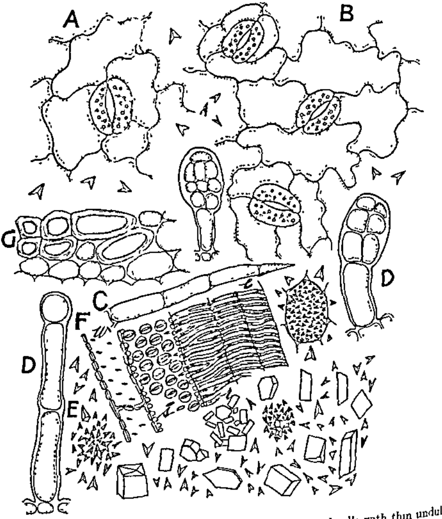


FIG 301 —Belladonna Leaf Of bifacial structure, epidermal cells with thin undulate walls, stomata and hairs (*A*) from the upper surface and (*B*) from the lower surface, a single palisade layer of short cells, a crystal layer of isodiametric parenchyma cells filled with sphenoidal microcrystals, the cells appearing grayish black; loose mesophyll with ... phloem occur
small bicollat
small groups
are tracheæ
walled porou
glandular ha
and many-ce
sphenoidal.
furrows are noted.

The plant is a perennial herb, growing up to a meter in height, indigenous to central and southern Europe and Asia Minor, and is cultivated in sunny locations in England, Germany, India and the United States. Belladonna was probably known to the ancients, but the first

authentic notice appears in 1504. The poisonous character of the plant was early known in the localities where it is indigenous. It was the subject of many treatises during the eighteenth century. Its mydriatic properties were first recorded in 1802 and its analgesic properties not until 1860. The leaves were used prior to the root, the latter not coming into general use until about 1860.

The stems are cut about half way down when the fruits begin to form and the alkaloids are most abundant. After rains or irrigation the plant produces a second crop of leaves and flowers, which is gathered in the fall. The roots are dug in the autumn, the larger ones being split to facilitate drying. Most of the herb crop is dried or partially dried and extracted with acidified water to obtain the alkaloids. A fine grade of leaf drug is obtained by hand picking the leaves and drying them rapidly at rather low temperatures and in the shade.

Description.—Leaf Drug (see Fig. 200). Usually in irregular, matted frag

yellowish purple, stamens 5, included, style somewhat exserted Fruit, a superior berry, globular, dark green, 7 to 10 mm in diameter, 2-locular, many-seeded

wn, testa finely

distinct, some-

Root Drug.—Cylindrical or tapering, somewhat branched, twisted, 0 5 to 4 cm. in thickness, occasionally split longitudinally, externally weak brown to moderate yellowish brown, or white where the soft periderm is abraded, fracture short and mealy, emitting a puff of dust consisting of starch grains and cell fragments, internally yellowish brown to pale yellow, slightly radiate; bark 0.5 to 2 mm. in thickness, not fibrous and adhering closely to the wood, cambium zone distinct; odor characteristic, somewhat narcotic when moistened,

01 and the U S. Pharma-

the National Formulary

Constituents —Belladonna contains hyoscyamine (in largest proportion), atropine, which appears to be derived from its isomer hyoscyamine and not to preexist in the root, scopolamine (hyoscine), belladonnine and apoatropine, both of which may be decomposition products of hyoscyamine, a fluorescent principle, *b*-methyl-æsculetin, sphenoidal crystals of calcium oxalate, malic acid in the leaf, and considerable starch in the root Total ash in leaf drug 9 to 16 per cent, in root drug about 5 per cent, acid-insoluble ash 0 3 to 0 7 per cent

The yield of alkaloids averages about as follows roots 0 6 per cent, stems 0 05 per cent, leaves 0 4 per cent, unripe berries 0 19 per cent, ripe berries 0 21 per cent, seeds 0 33 per cent

of bella-

iameter,

ses and

Roots

that are shrunken, spongy, dark brown in color, or free from starch are to be rejected.

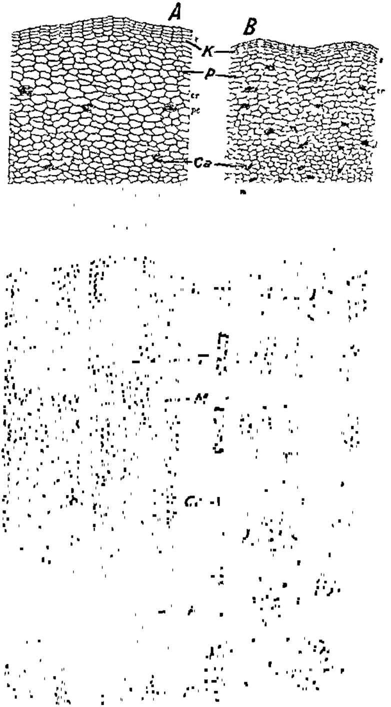


FIG 302 —Belladonna Root. *A*, transverse section of an older root in which the xylem ... in which the ... ed of a few ... ms, usually ... itively more ... d by medul- ... um oxalate. lary rays, the cells of the latter often containing starch or microcrystals of ... a conspicuous *cambium zone*; a broad xylem region composed of xylem wedges separated by medullary *rays* (*M*) the cells of the latter containing starch or microcrystals (*Ca*); the xylem wedges *contain* large reticulate tracheæ (*T*) in scattered groups separated by wood parenchyma (*P*) containing s ... late (*Ca*); the groups *of tracheæ are* associated with ... ous in older roots; the medullary *rays* (*M*)

Uses and Dose.—Belladonna stimulates the central nervous system, this effect being followed by depression. It decreases the flow of most secretions: saliva, milk, sweat.

the root drug externally in liniments, ointments and suppositories.

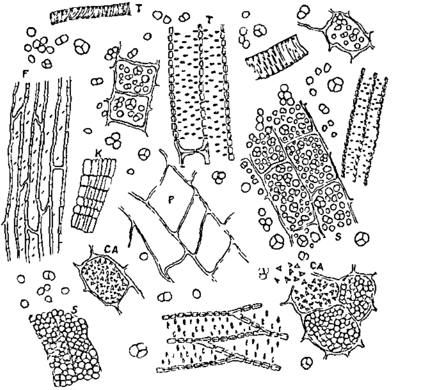


Fig. 303.—Powdered Belladonna Root. Ash gray to light brown; containing numerous

wood fibers (*F*) with narrow oblique pores, tracheæ with annular markings or simple pores (*T*) and fragments of parenchyma tissue (*P*).

Adulterants.—Belladonna Leaf has been adulterated or substituted with Scopola leaves, Poke Root leaves, and *Solanum nigrum* leaves. Belladonna Root has been admixed with Poke Root, Scopola rhizome, Althea root, or Inula root. Poke Root (root or leaves) is detected by the presence of raphides of calcium oxalate and the diamond-shaped bordered pores on the tracheæ.

The drug occurs in fusiform, somewhat bifurcated pieces and contains mandragorine (isomeric with atropine) and an alkaloid resembling hyoscyamine. Around this drug cluster many curious traditions. It was regarded with great veneration by the ancients, who recognized its narcotic properties.

Scopola (U. S. P. 1905 to 1916) is the dried rhizome of *Scopolia carniolica*, perennial herb growing in the region of the eastern Alps, Carpathian Mountains and neighboring regions.

The rhizome is nearly cylindrical, somewhat tortuous, up to 12 cm. in length and 15 mm. in diameter; frequently sliced longitudinally; externally grayish brown, longitudinally furrowed, slightly annulate, with numerous circular stem-scars about 5 mm. in diameter; lower portion with root-scars and root remnants; fracture short, mealy; internally whitish or light grayish brown, bark 1 mm. or less in thickness, wood slightly radiate, pith rather large, horny; odor slight; taste starchy, sweetish, acrid.

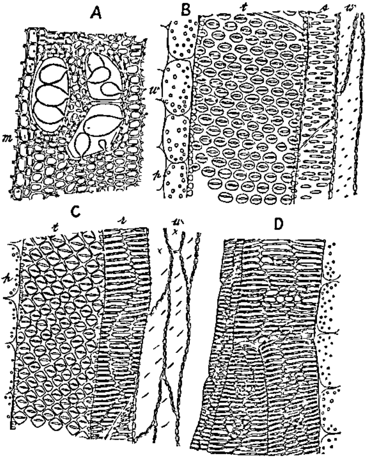


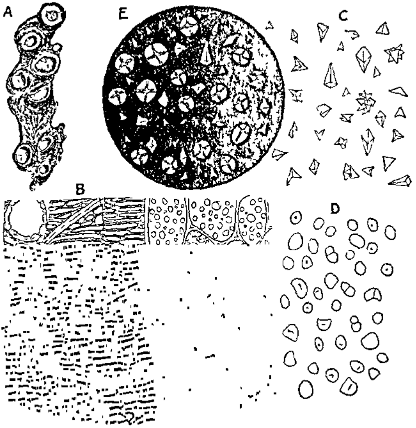
Fig. 304.—Different kinds of tracheæ. *A*, Transverse section of stem of grapevine (*Vitis vinifera*) showing three tracheæ from the older wood containing tyloses, *w*, wood fibers; *m*, medu... ths from ... rowth, ... howing ... s with ... ion of ... thick-ening (*r*), wood fibers (*w*) and parenchyma (*p*) containing starch. *D*, Longitudinal section of scopola rhizome showing the characteristic wide, reticulate tracheæ and portion of parenchyma containing starch

The roots, attached or in pieces, are cylindrical, tapering, from 2 to 10 mm in diameter, longitudinally wrinkled and marked by lenticular, whitish areas, resembling lenticels.

The structure of Scopola is illustrated in Figure 305.

Scopola contains about 0 6 per cent of total alkaloids, including atropine, hyoscyamine and scopolamine

Scopola resembles belladonna root in therapeutic activity, although it is somewhat more narcotic because of the presence of scopolamine



microns in diameter E, Field showing starch grains an…

Scopola Leaf is the dried leaf of *Scopolia carniolica* and is used in medicine like Belladonna Leaf The leaves are obovate, slightly acuminate and taper into the rather long petiole. The calyx lobes are relatively short and the capsular fruit (pyxis) is almost completely enclosed by the calyx tube A few glandular hairs may be present The tracheæ have annular, spiral or reticulate markings, and simple pores, but those with bordered pores do not occur. The sphenoidal crystals resemble those of belladonna In glycerine preparations, spherite aggregates of carbohydrates are formed, especially in the calyx. The epidermal cells of the leaves are irregularly papillose, giving a tuberculate

ings being more uniform and more marked than those in the similar cells of belladonna.

Japanese Belladonna ... and closely related ... contains the same ... also used.

The Solanaceous Alkaloids

The principal alkaloids of this group are hyoscyamine; its isomer atropine; scopolamine; and the anhydride of atropine, apoatropine and its isomer belladonnine. They are tropine derivatives, and are usually esters.

Hyoscyamine, $C_{17}H_{23}O_3N$, is the tropine ester of *l*-tropic acid, and is readily hydrolyzed by boiling in dilute acids or alkalis to form:

$$C_{17}H_{23}O_3N + H_2O \rightarrow \underbrace{\left|\begin{array}{ccc} CH_2— & CH— & CH_2 \\ | & | & | \\ & N.CH_3CHOH & \\ | & | & | \\ CH_2— & CH— & CH_2 \end{array}\right.}_{\text{Tropine}} + \underbrace{\begin{array}{l} C_6H_5 \\ | \\ CH.COOH \\ | \\ CH_2OH \end{array}}_{\text{Tropic acid}}$$

Hyoscyamine occurs in colorless crystalline needles and is levorotatory. When it is extracted from the plants in which it occurs it usually is racemized during the process, being thus converted into the *dl*-compound, which is atropine

Hyoscyamine Sulfate *(U. S. P. 1882 to 1916)* occurs as a white, fine, crystalline powder; it is very poisonous; 1 gm. is soluble in about 0.5 cc. of water, or 5 cc. of alcohol. Average dose, 0.5 mg.

Hyoscyamine Hydrobromide *(U. S. P. 1894 to 1936)* occurs as colorless crystals deliquescent in air, and very soluble in water, alcohol or chloroform. It is very poisonous. Average dose, 0.5 mg.

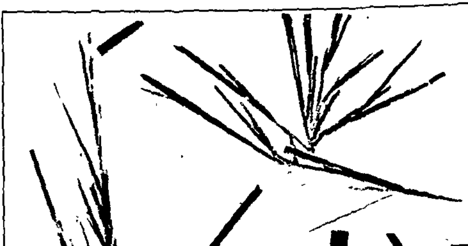


FIG 303.—Atropine Long orthorhombic prismatic crystals from an alcoholic solution

Atropine, $C_{17}H_{23}O_3N$, (U. S. P. 1863 to date) is an alkaloid usually obtained from *Atropa Belladonna* Linné, from species of *Datura* or of

Hyoscyamus, or produced synthetically. It is extremely poisonous. It is considered to be non-preëxistent in the Solanaceous plants (except in traces) but to be formed from hyoscyamine during the process of extracting the drugs.

Atropine occurs in colorless, needle-like crystals or as a white, crystalline powder, it is opticall [illegible]
mine, the limit of w [illegible]
Consult the U. S. P [illegible]
and purity. Average dose, 0.4 mg.

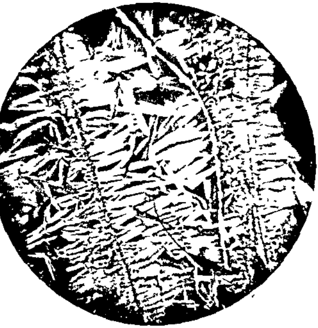


FIG. 307.—Scopolamine hydrobromide Crystal aggregates from an alcoholic solution

Atropine Sulfate (U. S. P. 1863 to date) occurs as colorless crystals or as a white crystalline powder. It is extremely poisonous. It effloresces in dry air, and is affected by light. Average dose, 0.5 mg.

[illegible]

It occurs as an almost colorless syrupy liquid from its chloroformic solution; as colorless crystals from its ether solution. It is levorotatory.

Scopolamine Hydrobromide or Hyoscine Hydrobromide (U. S. P. 1894 to date) ($C_{17}H_{21}O_4N.HBr.3H_2O$): Consult the U. S. Pharmacopœia for properties and tests. It is a powerful hypnotic said to cause sleep which very closely resembles natural sleep. Average dose, 0.5 mg.

Apoatropine or Atropamine, $C_{17}H_{21}O_2N$, occurs in the root of *Atropa Belladonna* in small quantity, and possibly in other Solanaceous plants. It can be prepared by heating atropine with nitric acid so as to cause the loss of one

molecule of water. It occurs in colorless, bitter, optically inactive crystals. It is weakly mydriatic, stimulates the medulla and spinal cord and accelerates respiration.

Belladonnine is a yellow, amorphous, viscid mass giving no crystallizable salts. It probably *contains apoatropine* or an isomer of it. It belongs to the atropine group pharmacologically but is *rarely used medicinally.*

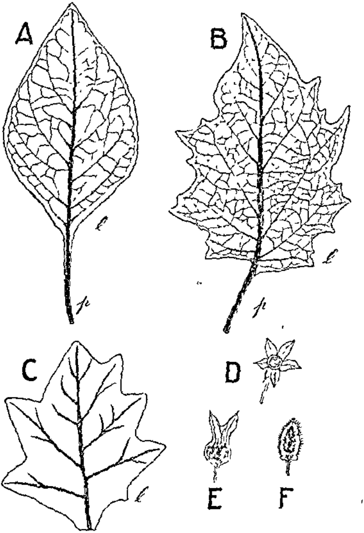


FIG. 303.—Leaves and fruits of Solanaceous drugs *A, D,* Belladonna, the inferior berry, cut transversely, showing numerous seeds; *B, F,* Stramonium, the fruit being a spinose capsule, *C, E,* Hyoscyamus, the fruit being a pyxis, surmounted by the large calyx lobes.

Homatropine Hydrobromide (U. S. P. 1905 to date) ($C_{16}H_{21}O_3N.HBr$) is the hydrobromide of a synthetic alkaloid formed by the interaction between tropine and mandelic acid. It is extremely poisonous.

Consult the U. S. Pharmacopœia for properties and tests The use of homat- [illegible] the *advantage* over [illegible] less *complete,* and

Homatropine Methylbromide or Novatropine, $C_{16}H_{21}O_3N.CH_3Br$, (N. F. 1947 to date), when dried at 100° C. for three hours, contains

not less than 3.7 and not more than 3.85 per cent of N. and not less than 21.3 per cent and not more than 21.9 per cent of Br.

FIG. 309.—Flowering branch of *Hyoscyamus niger annuus*, showing sessile, acutely lobed leaves and two of the funnel-form flowers. (After Newcomb.)

It occurs as an odorless, white, crystalline powder with a bitter taste. It is extremely poisonous. It is used as a sedative, especially for gastro-intestinal spasms. It is less toxic than atropine. Average dose, 2.5 mg.

Eucatropine Hydrochloride, $C_{17}H_{25}O_3N.HCl$ (U. S. P. 1942 to date), when dried over sulfuric acid for four hours, contains not less than 86 per cent and not more than 89 per cent of eucatropine.

It occurs as a white, granular, odorless powder, readily soluble in water, alcohol and chloroform. Its solutions are neutral to litmus paper. It is extremely poisonous.

The drug produces prompt mydriasis, free from anesthetic action, pain, irritation, etc., and is used mostly for its mydriatic effect.

Fig. 310.—Flowers of *Hyoscyamus pallidus*. (After Newcomb)

Pharmacologic Summary.—Atropine produces (1) complete paralysis *of the peripheral distribution of the parasympathetic nerves* (parasympathicolytic action), hence serves as a mydriatic; antisialagogue; antihydrotic; antidote to pilocarpine, muscarine and physostigmine; antispasmodic in colic, spastic constipation, etc.; for relaxation of the peripheral bloodvessels, hence a flushed skin and even erythema. (2) Atropine in small doses is a gentle stimulant to the respiratory and cardiac muscles. (3) Atropine on local applications causes a dullness or slight paralysis of the *sensory nerves*, hence used in liniments, ointments and suppositories it eases pain. (4) Atropine excites, then paralyzes certain cerebral and medullary centers, hence has a hypnotic, sedative and anesthetic effect.

To produce mydriasis, hyoscyamine is effective in one-half the concentration, scopolamine in one-fifth the concentration and homatropine in twice the concentration as that of atropine. On the other hand, the complete recovery from mydriasis with homatropine is but one-fifth as long as when atropine or scopolamine are used.

Hyoscyamine and scopolamine are used but little as mydriatics. They are definitely cerebral sedatives. Hyoscyamine is used to quiet excitability, especially in the insane; scopolamine is extensively used as a hypnotic in "twilight sleep," and has been suggested as a general anesthetic.

HYOSCYAMUS

Hyoscyamus or Henbane (U. S. P. 1820 to date) is the dried leaf, with or without the tops, of *Hyoscyamus niger* Linné and yielding not less than 0.040 per cent of the alkaloids of Hyoscyamus. *Hyoscyamus* is the ancient Greek and Latin name formed from two Greek words meaning hog and bean. The plant is said to be poisonous to swine.

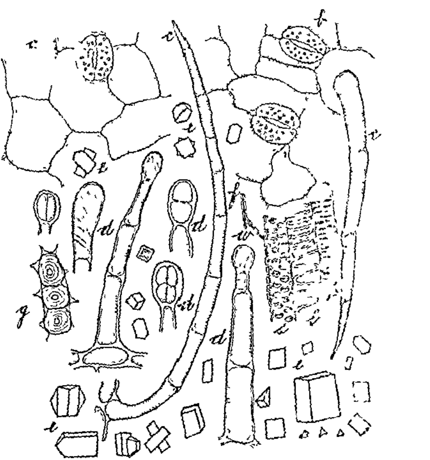


Fig. 311.—Hyoscyamus powder: grayish green to dark green, fragments of epidermis with nearly straight cell walls, stomata up to 35 microns long, and numerous hairs (a) from upper surface of leaf, (b) from lower surface; (c) non-glandular hairs uniseriate, 1- to 10-celled; glandular hairs (d) uniseriate, or with a 1- to 4-celled stalk and a 6- to 8- or many-celled head; calcium oxlate (e) mostly in monoclinic prisms up to 25 microns in length or rarely in rosettes or sphenoidal microcrystals, xylem fragments (f) showing spiral and dotted tracheæ and wood fibers with thin, porous, slightly lignified walls; fragments from midrib and stem showing strongly developed collenchyma, bast (g) and parenchyma; occasional pollen grains up to 40 microns in diameter, with 3 pores and 3 radiating furrows.

The plant is an annual or biennial herb (Fig. 309) indigenous to Europe, western Asia and northern Africa and cultivated in Russia, England and Germany, and to some extent in the United States and Canada. The biennial form is that most generally cultivated in Eng-

Purple Stramonium (*Datura tatula*), which is naturalized in the United States from tropical America, is similar to *D. stramonium*, but the stems and flowers are purplish. The constituents in the two plants are alike. Stramonium was grown in England about the sixteenth century from seeds obtained from Constantinople. The early settlers near Jamestown, Va., used it as a "pot herb" with fatal results, thus establishing its common name. It forms one of our most important sources of atropine.

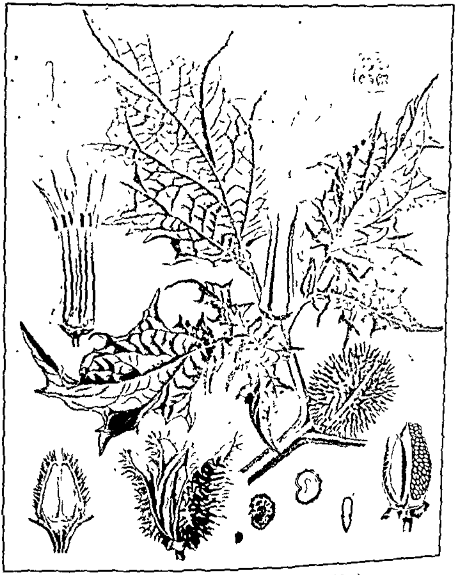


FIG 313 —*Datura stramonium*. (After Kohler)

DESCRIPTION.—Usually in irregular, matted masses. Stem cylindrical, flattened, longitudinally furrowed and wrinkled, 2 to 8 mm. in diameter. Leaves petiolate, ovate (Fig 313), 6 to 20 cm in length, apex *acuminate*; base unequal, margin irregularly sinuate-lobed, the lobes acute; surfaces grayish green to dusky olive green, glabrous except on lower surface of veins; texture fragile; flowers solitary; pedicel short, calyx 5-toothed, forming a collar at base of fruit; corolla white or purplish, plicate, funnel-shaped; stamens 5, epipetalous,

stigma bicarpellate. The immature fruit somewhat conical, 4-valved, covered with short, stiff emergences; seeds numerous Odor distinct, heavy and narcotic; taste unpleasant, nauseous.

STRUCTURE AND POWDER.—See Figures 314 and 315.

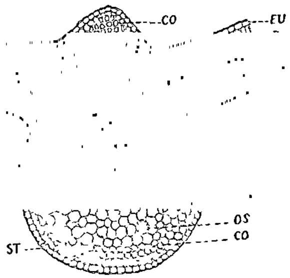


FIG 314 —Transverse section of midrib of leaf of stramonium *EU*, upper epidermis, *CO*, collenchyma *PA*, palisade cells, *O*, layer of cells containing rosette aggregates of

CONSTITUENTS — Hyoscyamine and atropine, the former being in excess; volatile oil, resin, total ash about 17 per cent, containing considerable potassium nitrate; acid-insoluble ash, about 0 2 per cent

The amount of total alkaloids from the same plant has been reported as follows roots, 0 2 per cent, stems, 0 02 per cent, leaves, 0 35 per cent, seeds, 0 40 per cent

USES AND DOSE — Stramonium has an action much like that of belladonna.

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leaves
hairs,

Stramonii Semen or Stramonium Seed (U. S. P. 1820 to 1905) is the ripe seed of *Datura Stramonium* Linné The ripening capsules are gathered and

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ing about one-
when the drug

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d dark brown contents;
s with distinct, crescent-
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he latter having 1 or 2

Stramonium Seed contains about 25 per cent of fixed oil; proteins; about 0.4 per cent of alkaloids, consisting principally of hyoscyamine, together with a small proportion of atropine and scopolamine; ash 2 to 3 per cent.

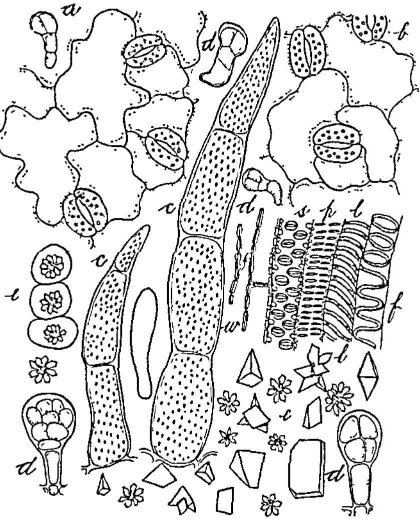


FIG 315 Stramonium powder epidermal cells with sinuate walls, (*a*) from upper surface of leaf, (*b*) from lower surface, stomata elliptical, about 25 microns long, and having 3 to 5 neighbor cells, (*c*) non-glandular hairs, usually only few and on the younger leaves, uniseriate, 2- to 6-celled [illegible] glandular hairs few, 1- to 2-ce[illegible] o
25 microns in c[illegible] -
ing spiral or pc[illegible] a
from the stem xylem

Stramonii Radix or Stramonium Root (U. S. P. 1842 to 1863) is the root of [illegible] branched, with a knotty [illegible]d and the drug carefully [illegible]tly atropine *It is often* included with the herb, which, partially dried and chopped into pieces, is extracted in huge tanks with acidified water to obtain the alkaloids. In medicine belladonna root has superseded it.

Floripondio Datura, the leaves of *Datura arborea*, indigenous to Chile and Peru and cultivated for its handsome flowers, contain 0.44 per cent of solanaceous alkaloids, the leaves are used in medicine.

Duboisia is the dried leaves of *Duboisia myoporides*, a large shrub indigenous to Australia. The leaves are short-petiolate, 7 to 10 cm. in length, 1.5 to 2 5 cm.

in width, with an acute apex and base, and an entire or somewhat revolute margin; in the drug, usually in thin greenish brown fragments, with a distinct odor and a bitter taste The drug contains hyoscyamine, scopolamine and pseudohyoscyamine, also a volatile alkaloid resembling piturine and nicotine.

The leaves of *Duboisia leichardtii*, of Australia, also contain a relatively large percentage of alkaloids.

Pituri or Australian Tobacco is the leaf of *Duboisia hopwoodii* and is used in Australia like tobacco. It contains 2.5 per cent of a liquid alkaloid, piturine, which has a pungent odor and taste and resembles nicotine.

Folia Nicotianæ or Leaf Tobacco (U. S P. 1820 to 1905) consists of the cured and dried leaves of the Virginia tobacco plant, *Nicotiana tabacum*. *Nicotiana* was named after Jean Nicot, a French diplomat, who probably introduced tobacco into Europe, *tabacum*, or Spanish *tabaco* refers to the Indian name for the "pipe" or tube used for smoking it

The plant is a tall annual herb indigenous to tropical America and widely cultivated The stem is simple, giving rise to large, pubescent, ovate, entire, decurrent leaves, the veins of which are prominent and more or less hairy. The flowers are long, tubular, pink or reddish and occur in terminal spreading cymes The leaves are hung in barns, and slowly cured and dried, using a little heat if the weather is cold or damp Other species of *Nicotiana* are also cultivated, as *N. persica*, which yields Persian tobacco; and *N rustica*, the source of Turkish tobacco

The powder is greenish brown and shows 3- to 6-celled, non-glandular hairs, with a broad basal cell and not infrequently branching apical cells, glandular hairs of two kinds, either with a 1-celled stalk or a 3- to 5-celled stalk, the head in each case being rather small and with 8 to 9 cells; stomata large and with 2 or 3 neighbor cells, epidermal cells striated and somewhat granular on surface view, the cells of the mesophyll with a greenish brown content, some containing sphenoidal microcrystals

Tobacco leaves contain from 0 6 to 9 per cent of the alkaloid nicotine, an aromatic principle, nicotianin, or tobacco camphor, to which the characteristic flavor is due and which is formed during the curing of the leaves The dried leaves yield from 14 to 15 per cent of ash, consisting in large part of potassium nitrate

Commercial tobacco has been adulterated with chestnut, cherry, rose, melilot, cabbage, chicory, beet and burdock leaves

In the manufacture of plug tobacco various other substances are added, as licorice, cloves, anise, orris root, vanilla, deer's tongue leaves, tamarinds, prunes, etc

Tobacco is a narcotic, a sedative, a diaphoretic and an emetic

Nicotine, $C_{10}H_{14}N_2$, is an alkaloid obtained from cured tobacco (commercially from the stems, petioles, midribs, trimmings and dust from tobacco factories) in which it is present as citrate or maleate The alkaloid is an oily, volatile liquid, colorless to yellow, slowly becoming brown on exposure to air, taste exceedingly acrid and pungent, odor of pyridine It is very poisonous It is a local irritant and paralyzant Its salts (hydrochloride, salicylate and tartrate) occur as colorless crystals, readily soluble in water and considerably used in medicine Nicotine salts, and largely a concentrated extract of tobacco containing about 40 per cent of nicotine, are used in sprays on fruit trees and other plants to destroy aphids or plant lice

SOLANUM

Dulcamara or True Bittersweet (U S P 1820 to 1905, N F 1916 to 1936) is the dried stem of *Solanum Dulcamara* Linné

Solanum or Horse Nettle Berries (N F. 1916 to 1936) consists of the air-dried ripe fruit of *Solanum carolinense* Linné.

Potato is the tuber of *Solanum tuberosum* Linné.

Eggplant is the nearly ripe fruit of Solanum Melongena.

Tomato is the fresh ripe fruit of *Lycopersicon esculentum* (*Solanum lycopersicum*).

Solanum Nigrum, or Black Nightshade is the flowering and fruiting herb of *Solanum nigrum* Linné.

Solanum is the ancient Latin name for Nightshade; *carolinense* refers to habitat; *Dulcamara* is from the Latin meaning sweet and bitter; *tuberosum* is Latin and refers to the enlargements or tubers on the slender rhizomes; *esculentum* refers to the edible nature of the fruit.

These plants all possess a bitter gluco-alkaloid identical with or similar to solanine. It occurs in the green parts of the potato plant, in the tubers (if green from the sunlight), a ... found in the leaves and fruits of ... green fruit of tomato and egg ... were quite poisonous.

Solanum dulcamara is a woody climber, indigenous to Europe and Asia, growing in moist thickets in the northern ... Canada and to some extent cultivated. The fruit ... sometimes eaten by children with fatal ef... twigs are gathered in the early spring or the late fall, cut into small pieces a... dried.

Dulcamara is in short, hollow, cylindrical pieces, from 4 to 6 mm in diameter, outer surface yellowish or greenish brown, longitudinally wrinkled or furrowed and frequently showing leaf-scars and a development of scaly cork; internally showing a thin, yellowish brown corky layer, a small, dark brown, somewhat lamellated cortex, a broad, yellowish, porous wood, and a large hollow pith; odor slight, distinct; taste of bark bitter, and of wood sweetish.

The powder is light yellowish brown, and contains *fragments* of lignified wood fibers having bordered pores, and associated with a few wide tracheæ possessing simple pores; occasional non-lignified bast fibers and fragments of ...

alcohol, slightly soluble in hot alcohol, sparingly soluble in boiling water and upon hydrolysis yields dextrose and a crystalline alkaloid, solanidine. Total ash, having a greenish color, about 6 per cent, with about 0.7 per cent of acid-insoluble ash.

Dulcamara has been used as a sedative and hypnotic; also as a diaphoretic and a diuretic. It is also claimed to be of value as an alternative and resolvent in some skin diseases.

Solanum is from a perennial herb found in dry fields and waste places in the eastern and central United States. The fruit is a superior globose berry, collected when ripe, during the summer, and carefully dried. ... externally

Solanum is glo... ... sub-
yellowish brown ... rittle;
tended by the 5-l... ... oadly
... earing numerous seeds; the latter ... 2 mm. in
flattened, campylotropous, about ... somewhat
and nearly smooth; odor slight, somewhat

...lls of the outer epidermis from 138 to 250
microns in length wi... ... 15 microns
in thickness, epicarp ... morphous
content; portions of ... collapsed
... microns
cells, some containing nearly spheroidal starch grains, the latter ...

n diameter; narrow tracheæ with spiral or reticulate thickenings; occasional microcrystals.

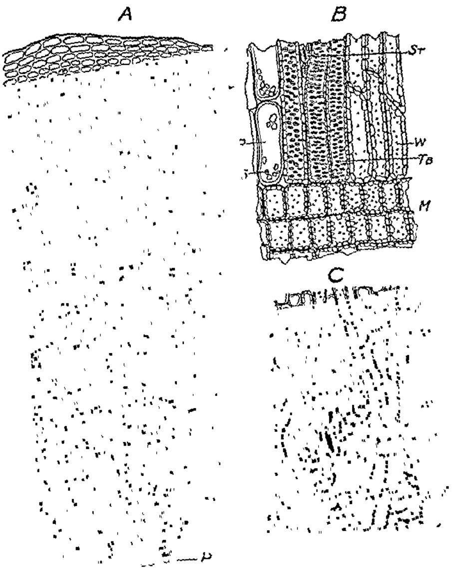


FIG. 316.—Manaca. *A*, transverse section of root. *K*, thin-walled cork which arises in the epidermal layer. *Ct*, cortex consisting mostly of starch-bearing parenchyma, and cells containing either rosettes of calcium oxalate or a yellowish brown amorphous content, the larger cells of which are mostly spheroidal in shape and usually lined with a thin layer of protoplasm. *L*, small strands of leptome. *W*, wood fibers. *M*, medullary rays consisting mostly of rectangular cells, having thick, porous walls. *An*, cells marking the rings of growth between the spring and fall wood as also of the cambium, usually filled with a yellowish brown amorphous substance. *St*, stone cells, usually developed between the wood fibers and medullary rays. *B*, Longitudinal section showing tracheæ having bordered pores (*Tb*), parenchyma (*P*), starch grains (*S*) being from 4 to 15 microns in diameter, wood fibers (*W*), thick-walled medullary ray cells (*M*), stone cells (*St*). *C*, Tangential section showing medullary ray cells (*M*), starch (*S*), wood fibers (*W*), stone cells (*St*). (Drawing by Hasse.)

Solanum contains an alkaloid, solanine, which crystallizes in orthorhombic prisms, that are insoluble in water and very soluble in chloroform and hot alcohol, and have an acrid and bitter taste, leaving a persistent tingling sensation on the tongue.

Solanum is an antispasmodic and a sedative.

Manaca (N. F. 1926 to 1936) is the dried root of *Brunfelsia hopeana*, a large shrub growing along streams in Brazil and other parts of tropical America. While all parts of the plants are used in Brazil, only the root has been introduced into general medicine.

[illegible]

is shown in Figure 316.

Manaca contains manacine, a very poisonous alkaloid, resembling strychnine [illegible] s manaceine, and a resinous substance [illegible] 'in.

[illegible] matism and syphilis.

CAPSICUM

Capsicum or Cayenne Pepper (U. S. P. 1820 to 1942; N. F. 1942 to date) is the dried fruit of *Capsicum frutescens* Linné, known in commerce as African Chillies, or of *Capsicum annuum* Linné var. *conoides* Irish, known in commerce as Tabasco Pepper, or of *Capsicum annuum* var. *longum* Sendt, known in commerce as Louisiana Long Pepper, or of a hybrid between the Honka variety of Japanese Capsicum and the Old Louisiana Sport Capsicum known in commerce as Louisiana Sport Pepper. Capsicum must be labeled to indicate which of the above varieties is contained in the package. Capsicum yields not less than 12 per cent of a non-volatile ether-soluble extractive.

Capsicum, from the Latin *capsa*, meaning a "box," refers to the partially hollow, box-like fruit; *frutescens*, Latin, refers to the shrubby character of the plant; and *annuum*, Latin, refers to the annual character of the plant.

Capsicum frutescens is a small spreading shrub, up to 1 meter high, indigenous to tropical America and cultivated in tropical localities in Africa, India, America and Japan. Apparently, the more tropical the climate, the r [illegible] annual form [illegible] central and s [illegible] tries, under the names of Garden Pepper, Paprika, Pimiento, [illegible] Chillies, Tabasco Pepper, etc. All of these are less pungent than African Chillies, but are very desirable as condiments. The medicinal value of capsicum is as a rubefacient, which value depends upon its pungency. The U. S. Pharmacopœia recognized only the African Chillies as a medicinal agent for one hundred and twenty-two years; when a pungent controversy over the admission of *Capsicum annuum* to the monograph arose, the Revision Committee chose to delete the monograph, rather than to degrade it. The N. F. Committee admitted the monograph and the inferior Louisiana Peppers; now it can be

expected that capsicum will soon disappear from the medicinal field, for when the official standards of a drug are degraded, that drug soon disappears from medicine.

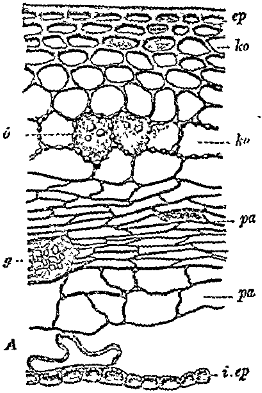


FIG. 317.—Garden pepper (*Capsicum annuum*). *A*, transverse section of pericarp showing epidermis (*ep*), hypodermis (*ko*), (*kp*) secretion cells having thick, porous suberized walls and containing oil (*o*) and resin, parenchyma (*pa*), fibrovascular bundle (*g*), inner epidermis (*i, ep*) composed of thick, lignified, porous cells.

African cayenne comes chiefly from the ports of Mombasa and Zanzibar in East Africa and Sierre Leone in West Africa, and is usually designated in the trade by the port named. Japanese chillies, usually exported from Kobe, are somewhat less pungent than African capsicum, but more pungent than Madras or Bombay chillies from British India. Of the 2 to 3 million pounds annually imported into the United States, about one-half comes from British India, one-third from Japan and one-sixth from Africa. Only the African should be used in medicine.

Capsicum was *first referred to in 1494 by Chanca, a physician who* accompanied Columbus on his second voyage to the West Indies. Plants were introduced into India by the Portuguese at an early date and later into Africa. Capsicum is official in nearly all the pharmacopœias of the world.

DESCRIPTION.—African chillies are oblong, conical, laterally compressed, from 10 to 25 mm. in length and from 4 to 8 mm. in diameter, rarely with a

remnant of the calyx and a short pedicel; externally brownish red, glabrous, shiny, somewhat translucent, more or less shriveled; apex acute, base somewhat rounded; pericarp thin, brittle or somewhat coriaceous; inner surface with two or three distinct longitudinal ridges, longitudinally striate, 2- or 3-locular, dissepiments thin, united below; seeds 6 to 20, campylotropous, irregularly circular or obovate, flattened, pointed, about 2 to 4 mm. in diameter, 0.5 mm. in thickness, edge slightly thickened, embryo curved, embedded in the endosperm; odor distinct, sternutatory; taste extremely pungent.

STRUCTURE.—See Figures 317, 318, 319, and the National Formulary.

POWDER.—Yellowish brown to brownish red; outer epidermis of pericarp mostly of quadrangular cells up to 80 microns long arranged in regular rows (Fig. 318), with thickened and cutinized outer and radial walls, the surface of the cuticle finely striated and the radial walls somewhat wavy and very slightly beaded; inner epidermis of pericarp of elongated cells, some of them very thin-walled, others in large oval areas with thickened, beaded, lignified walls, seed epidermal cells up to 250 microns in length, with very wavy, contorted, lignified

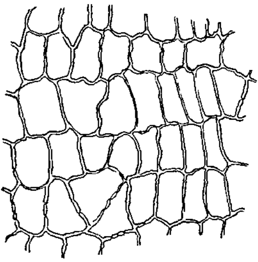


FIG. 318.—Cayenne Pepper (*Capsicum frutescens*). Surface section of the epi-

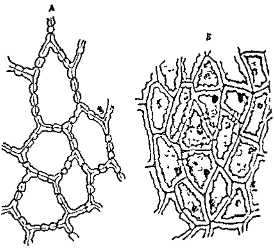
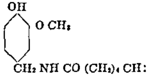


FIG 319.—Garden Pepper (*Capsicum annuum*) ... and *B*, hypodermis ... walls and non- ... rawings by L. N

walls, collenchymatous cells with suberized walls and containing yellowish-red oil globules and irregular masses of chromoplastids; small, thin-walled parenchyma cells from the endosperm containing aleurone grains and fixed oil; small, spheroidal starch grains, single or compound, from unripe fruits, rare; glandular hairs with 1- to 3-celled stalks and multicellular heads from the calyx, rather rare

Tabasco Peppers are about twice the size, and the Louisiana Peppers up to ten times the size of African Capsicum. The outer epidermis of the pericarp of these pepr ... cells with thickened and strongly ... ated cells with thickene ... red cellu- lose These ... owdered form, from genuine African capsicum (see Figs 317 and ...

CONSTITUENTS.—Capsicum contains capsaicin (about 0.02 per cent), an extremely pungent principle in the dissepiments of the fruit. Capsaicin is a phenol having the formula.



Capsaicin imparts a distinctly pungent taste to water, even when diluted

Hungarian paprika is particularly rich in ascorbic acid (vitamin C).

STANDARDS.—Capsicum contains not more than 3 per cent of its stems and calyxes, and not more than 1 per cent of other foreign organic matter, yields not less than 12 per cent of non-volatile, ether-soluble extractive and not more than 1 25 per cent of acid-insoluble ash.

Thoroughly mix 1 gm. of powdered capsicum with 50 cc. of alcohol and

equivalent to 1 part of capsicum in 70,000 parts of sweetened water. Japanese capsicum so diluted 1 in 50,000 or Indian capsicum 1 in 40,000 will give about the same degree of pungency Paprika and other capsicum fruits permit less dilution even down to 1 in 5000

USES AND DOSE —Capsicum is used as a rubefacient, it is also a stimulant and a condiment. Average dose, 60 mg

ADULTERANTS —Powdered capsicum is sometimes admixed with about 1 per cent of a fixed oil to improve its appearance, and such powders are likely to contain in addition some of the commercial starches or by-products obtained in the manufacture of cereal products.

Less pungent varieties are occasionally admixed with the drug. These may be readily detected by the character of the epicarp Capsicum is itself used to enhance the pungency of other spice drugs, notably black pepper, ginger and mustard.

ALLIED DRUGS.—**Japanese Capsicum** is conical, from 15 to 44 mm. long, bright red externally, with usually more than 20 seeds and very rarely with an adherent calyx and peduncle.

in diameter.

Rosenpaprika, Rozsapaprika, or Rose Paprika, is Hungarian paprika prepared by grinding specially selected pods of paprika, from which the placentæ, stalks,

and stems have been removed. It contains no more seeds than the normal pods, not more than 18 per cent of non-volatile ether extract, not more than 23 per cent of crude fiber, not more than 6 per cent of total ash, nor more than 0.4 per cent of ash insoluble in hydrochloric acid. It possesses a beautiful red color and a pungent, savory taste.

Königspaprika, or King's Paprika, is Hungarian paprika prepared by grinding whole pods of paprika without selection and includes the seeds and stems naturally occurring with the pods. It contains not more than 18 per cent of non-volatile ether extract, not more than 23 per cent of crude fiber, not more than 6.5 per cent of total ash, nor more than 0.4 per cent of ash insoluble in hydrochloric acid.

Pimenton, Pimiento, or Spanish Paprika, is paprika having the characteristics of that grown in Spain. It contains not more than 18 per cent of non-volatile ether [illegible]
8.5 per cent o[illegible]
chloric acid. [illegible]
[illegible] or, and with no perceptible
[illegible] and a peculiar odor. The
[illegible] it odor. The placentæ are
[illegible] arp.

SCROPHULARIACEÆ, OR FIGWORT FAMILY

This is a large family, represented by 205 genera and nearly 2600 species of herbs, shrubs or trees. The plants are characterized by having gamopetalous corollas, which may be nearly regular but are usually 2-lipped, the stamens being frequently didynamous and the fruits usually capsular. Among the anatomical characteristics the following may be mentioned: neither a subepidermal collenchyma nor a sclerenchymatous ring in the pericycle are developed; calcium oxalate is secreted in the form of small prisms, octahedra or acicular crystals. The non-glandular hairs are: (a) unicellular; (b) uniseriate; (c) unicellular, having cystoliths; and (d) multicellular, or branching, as in *Verbascum* and *Paulownia*. The glandular hairs are (a) those having a unicellular stalk and a unicellular secreting head; (b) those having a 2- or more-celled glandular head; (c) peltate-glandular. The mesophyll of the leaves contain not infrequently crystals of carotin, or protein substances. In *Scrophularia*, idioblasts containing tannin extend from the epidermal layers to the fibrovascular bundles.

DIGITALIS

Digitalis or Foxglove (U. S. P. 1820 to date) is the dried leaf of *Digitalis purpurea* Linné. Its potency is such that, when assayed as directed, 0.1 gm. shall be equivalent to not less than 1 U. S. P. Digitalis Unit or 0.1 gm. of the U. S. P. Digitalis Reference Standard.

Powdered Digitalis or Digitalis Pulverata (U. S. P. 1936 to date) is Digitalis dried at a temperature not exceeding 60° C. to a moisture content of not more than 5 per cent, reduced to a *fine powder* and adjusted, if necessary, so that 0.1 gm. of it shall be equivalent to 1 U. S. P. Digitalis Unit (a variation of not more than 20 per cent from

standard in the assay results is permitted). When Digitalis is prescribed, Powdered Digitalis is to be dispensed.

Digitalis is from the Latin *digitus*, meaning a finger, and refers to the finger-shaped corolla; it was so named by Tragus in 1539; *purpurea* is Latin and refers to the purple color of the flower. The plant is a biennial herb, probably indigenous to central and southern Europe and

FIG. 320 Specimen plant of *Digitalis purpurea*, grown in the Medicinal Plant Garden, University of Minnesota (Photo by Newcomb.)

naturalized in various parts of Europe and in northern and western United States and Canada The leaves are collected from both the first and second year plants, usually from July to September. They may average higher in glucosides just before the expansion of the flower, and sunlight favors production of glucosides which at night appear to be partially hydrolyzed. Collections should be made in the afternoon,

FIG. 321.—Cultivation of Digitalis. A general view of the Experimental Farm of Eli Lilly & Co., showing the testing and breeding of various species and varieties of *Digitalis*. (After Miller.)

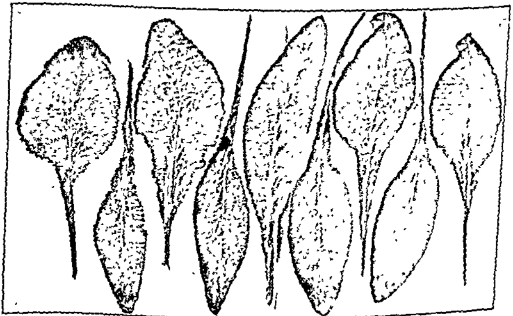


FIG. 322.—*Digitalis purpurea*. Leaf variations in different plants. It will be noted that the leaves vary in shape, margins and character of the petioles. There is also considerable difference in the color of the leaves and their surfaces. These variations seem too great and diversified to be explained as individual variabilities. (After Miller.)

be dried rapidly and thoroughly at a temperature of 55° to 60° C. in a drying room, then stored in water-proof air-tight containers. Some digitalis is imported from England and central Europe, but the larger supply comes from plants cultivated in Pennsylvania, the Pacific Northwest and Minnesota. Digitalis seems to have been used externally

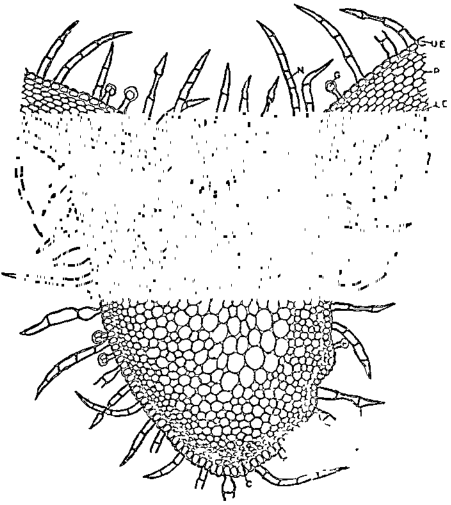


FIG. 323.—Transverse section of Digitalis leaf through one of the veins. *UE*, upper epidermis, *P*, chlorenchyma (mesophyll), containing chloroplastids. *LE*, lower epidermis. *G*, glandular hairs. *N*, non-glandular hairs. *C*, collenchyma. *T*, tracheæ or vessels, *S*, leptome or sieve.

by the Welsh. Parkinson recommended it in 1640, but its internal use was not in vogue until its recommendation by Withering in 1776. It has been official in most pharmacopœias since the eighteenth century and in all editions of the U. S. Pharmacopœia.

DESCRIPTION.—Usually more or less crumpled and broken into fragments, lamina ovate or ovate-lanceolate, 10 to 35 cm. in length, 5 to 11 cm. in breadth,

The Glycosides of Digitalis

The active constituents of Digitalis are frequently referred to as the *cardiac glycosides* because they are characterized by the highly specific and powerful action which they exert upon the cardiac muscles. In the natural state the glycosides are associated with saponins, also glycosidic substances, which affect the solubility of the cardiac principles, but are inert therapeutically. Though the pharmacological activity of the glycoside resides in the aglycone portion of the molecule, the sugars when combined with the aglycones increase both the potency and toxicity of the active principle. In addition the sugars affect certain physical properties of this chemical combination, such as water sol-

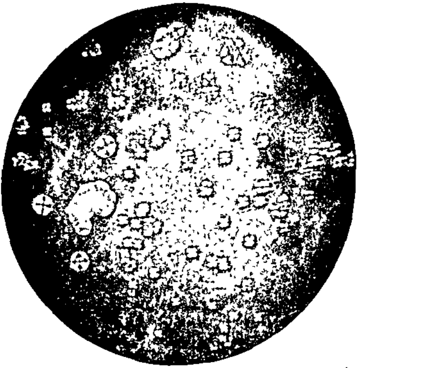


FIG. 326.—Digitoxin sphero-crystals from an alcoholic solution.

ubility and diffusion through semi-permeable membranes and thera-
peutically they determine the persistence of the cardiac action. The
aglycones can be desugared by acid or enzymatic hydrolysis. Chemi-
cally, the aglycones are related to the bile acids and sterols, have an
empirical formula as $C_{23}H_{34}O_{(4-8)}$. The basic structure is a cyclopenteno-
phenanthrene nucleus to which is attached a lactone ring. The unsat-
urated *lactone ring is indispensable whereby* a reduction of the double
bond reduces its toxicity and if there is a complete disappearance of the
double bonds the compound is therapeutically inactive. In addition ... the stereo-
... activity
... *different*
... soluble
solubilities in aqueous and organic solvents. They are ...

in water or aqueous alcohol and almost insoluble in the usual fat solvents with the exception of chloroform and ethyl acetate. They can be obtained from the drug by exhaustive extraction with methyl alcohol.

Constituents of Digitalis Purpurea.—The important constituents are purpurea glycosides A and B, and gitalin There are also present digitonin, hy
frequently
A and B,

yield the same sugar, but different aglycones, namely digitoxigenin, gitoxigenin and gitaligenin respectively. Digitoxin and gitoxin each yield three molecules of digitoxose and gitalin only two molecules.

Digitoxin (U. S. P. 1947 to date) is a well-defined, colorless, odorless, crystalline, bitte
into solution in
in that menstru
green with hydrochloric acid It may be identified by Keller's reaction, which consists in dissolving it in glacial acetic acid, adding a drop of ferric chloride solution, and then, gently, sulfuric acid to form a layer below the acetic acid. A brownish green band is first formed after which the acetic acid layer becomes greenish blue and then indigo blue, while the sulfuric acid becomes brownish red. Digitoxin is the most toxic of the active constituents of the leaves, and is accumulative in action.

Gitalin is one of the three main glycosidal fractions of *Digitalis purpurea*. It was first obtained from a cold water extract of digitalis leaves by Kraft in 1912. He gave it the name "Gitalin"; it was subsequently introduced into clinical practice under the name of "Verodigen." It is not to be confused with the chemically pure glycoside gitalin, which has an empirical formula of $C_{35}H_{56}O_{12}$ and occurs as white rosettes melting at 245° C The commercial product gitalin, recognized by the N. N. R., is an amorphous substance and probably not a chemical individual. It is a yellowish-white amorphous powder, which is very soluble in chloroform and alcohol and in about 800 parts of cold water. In the dry state it is quite stable retaining its action without any change in potency or deterioration over periods as long as two years Pharmacological and clinical reports claim for it all the effects produced by whole digitalis preparations, with more accurately controllable conditions of absorption and therapeutic action.

hy
sol
treatment with hydrochloric acid, but a sulfuric acid solution becomes garnet-red in color on boiling for some time Digitonin, when anhydrous, occurs as an amorphous body, while with $5H_2O$ it is a crystalline, chemically uniform body.

Constituents of Digitalis Lanata.—Stoll isolated from the leaves of *Digitalis lanata* three chemically pure glycosides, known as lanatoside A, lanatoside B, lanatoside C, also known as digilanid A, digilanid B, and digilanid C, respectively. They all contain an acetyl group which on alkaline hydrolysis can be split off, giving rise to deacetyldigilanids A, B and C. Stoll also demonstrated that an enzyme, lanatosidase present in the leaves, splits one molecule of glucose from each of the compounds, leaving the acetyl glycosides. Upon alkaline hydrolysis these compounds lose the acetyl group, yielding the corresponding glycosides. These glycosides are digitoxin from lanatoside A, gitoxin from lanatoside B, and digoxin from lanatoside C. On enzymatic hydrolysis of the lanatosides, both the glucose molecule and the acetyl group are removed and the respective glycosides are liberated. Two of these glycosides, digitoxin and gitoxin, found in *Digitalis purpurea* are identical with the corresponding glycosides derived from lanatoside A and B, respectively. Digitoxin and gitoxin from both sources on further acid hydrolysis each yields three molecules of the same sugar, digitoxose and the corresponding aglycones, digitoxigenin and gitoxigenin, respectively. At the same time no counterpart of the glycoside digoxin, obtained from lanatoside C, can be found in *Digitalis purpurea* while gitalin in the latter cannot be found in *Digitalis lanata.* Stoll demonstrated that the glycosides digitoxin and gitoxin are actually degradation products of the compounds as they exist in the natural state. These natural glycosides in *Digitalis purpurea* are identical with those in *Digitalis lanata* except that they lack the acetyl group. The yield of pure genuine glycosides from *Digitalis purpurea* is very much smaller than that from *Digitalis lanata.* The components in both kinds of digitalis plant vary in different specimens within one and the same species and in different localities. The proportion of the three components in the average digilanid mixture has been found to be about 46 per cent of lanatoside A, 17 per cent of lanatoside B, and 37 per cent of lanatoside C.

Lanatoside C (U. S. P. 1947 to date) is a pure substance possessing a characteristic crystalline form with a melting point of 245° to 248 °C. It is easily soluble in methyl or ethyl alcohol. Although only slightly soluble in water, this solubility suffices for its therapeutic use. The empiric formula is $C_{49}H_{76}O_{20}$. On enzymatic and alkaline hydrolysis the glucose and acetyl radicles are liberated, leaving the glycoside digoxin. Further acid hydrolysis splits off three molecules of digitoxose leaving the aglycone, digoxigenin. Lanatoside C is a stable, easily absorbed, and promptly effective preparation which can serve as a potent therapeutic agent.

Digoxin (U. S. P. 1947 to date) is derived by hydrolytic cleavage from the natural glycoside lanatoside C of *Digitalis lanata,* or *Digitalis orientalis* and is formed by a chemical combination of a pentose sugar, digitoxose, with the cardioactive aglycone, digoxigenin. It is a stable crystalline substance. The drug is promptly and fairly completely absorbed and is cumulative.

…ig. 327. Upper left: *Digitalis lanata*. Upper right: *Digitalis ambigua*. Lower … *Digitalis purpurea*. Lower right: *Digitalis sibirica*. (The Glenolden Experimental …dens.)

USES AND DOSE.—Digitalis increases the contractility and improves the tone of the cardiac muscle; both reactions resulting in a slower but much stronger heart beat; also digitalis stimulates the vagus center, which tends to diminish the cardiac tone and excitability, thus counteracting the stimulating and strengthening effect of the peripheral action. This explains the need of careful dosage to be determined experimentally for each patient. The effective thera- [illegible] -u- [illegible] -ne [illegible] -m-
pensate for mechanical defects or structural lesions. The finely powdered leaves or the tincture are still considered the most desirable forms for digitalis medication.

ADULTERANTS.—In times past digitalis leaf has been adulterated or substituted with several kinds of hairy leaves, such as those of. *Piper angustifolium* (Fam. *Piperaceæ*), *Salvia Sclarea* (Fam. *Labiatæ*), *Verbascum phlomoides* or *D. thapsus* (Fam. *Scrophulariaceæ*), *Inula conyza* (Fam. *Compositæ*); also from several non-official *Digitalis* species, as *D. monstrosa*. Since standards have become more stringent, practically all adulteration of digitalis, except with inferior quality of the true drug, has ceased.

ALLIED DRUGS.—**Digitalis grandiflora,** growing abundantly in Switzerland, produces leaf drug said to be as effective as the official Digitalis.

Digitalis Lutea or Straw Foxglove is the dried leaves of *Digitalis lutea*; [illegible] -nd appears to be almost identical [illegible]

D[illegible] -e dried leaves of *Digitalis ferruginea* and is nearly twice as toxic as the official drug, the activity, however, is similar.

Digitalis Lanata or Grecian Foxglove is the dried leaves of *Digitalis lanata*, a plant indigenous to southern and central Europe and cultivated in southern California.

Digitalis Thapsi or Spanish Digitalis is the dried leaves, usually with the stems, flowers and capsules of *Digitalis thapsi*.

LEPTANDRA

Leptandra, Culver's Root or Veronica (U. S. P. 1820 to 1831, 1863 to 1916; N. F. 1916 to date) consists of the dried rhizome and roots of *Veronicastrum virginicum* (Linné) Farwell (*Veronica virginica* Linné). The name *Leptandra* is from two Greek words meaning slender and man, referring to the slender stamens; *Veronica* refers to St. Veronica.

The plant is a perennial herb growing in meadows and moist woods of the eastern and central United States and Canada. The rhizome and roots are collected in autumn from plants of the second year's growth. When fresh the drug has an almond-like odor and a bitter, nauseous taste, which it loses in a measure on drying. It may be kept indefinitely. Most of the commercial supply comes from Virginia and the Carolinas. The plant is often cultivated for its beautiful flowers. The plant was widely known to the American Indians; it was employed by them, as well as the white settlers, as a violent purgative. Its use was confined to domestic medication until about 1852 when it entered professional medicine.

DESCRIPTION.—Rhizome horizontal, nearly cylindrical, somewhat branched, 4 to 10 cm in length, 3 to 13 mm in diameter; externally weak brown to moderate yellowish brown; upper surface with conical buds, short stem remnants or

stem-scars, under and side portions with numerous roots or root-scars; fracture

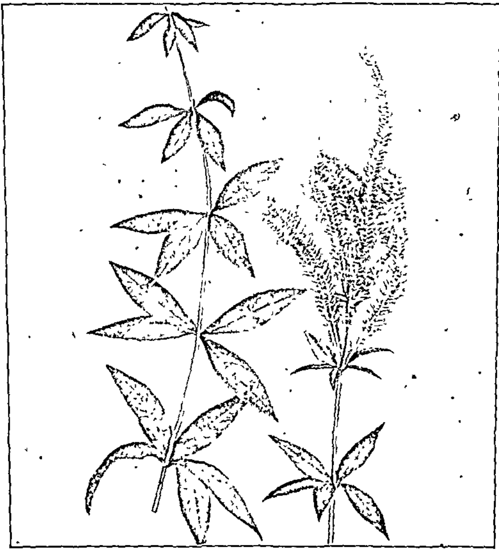


Fig. 328.—Culver's Root (*Leptandra virginica*) showing the verticillate leaves and the long spike-like terminal racemes.

Structure.—See Figure 329 and the National Formulary.

Powder.—Pale brown to light yellowish [illegible]
and a very bitter, acrid taste; parenchyma [illegible]
brownish black resin, the latter frequently [illegible]
grains in the cells; starch grains numerous, [illegible]
polygonal, and up to 9 microns in diameter; tracheæ with spiral thickenings or simple or bordered pores; wood fibers with thick lignified porous walls,

resembling tracheids; fragments containing a pigment which is colored pink or violet upon the addition of chloral T.S.; epidermal cells of the root having thick lamellated walls.

CONSTITUENTS.—An amorphous substance having an intensely bitter and nauseous taste and yielding on hydrolysis a resinous material and cinnamic

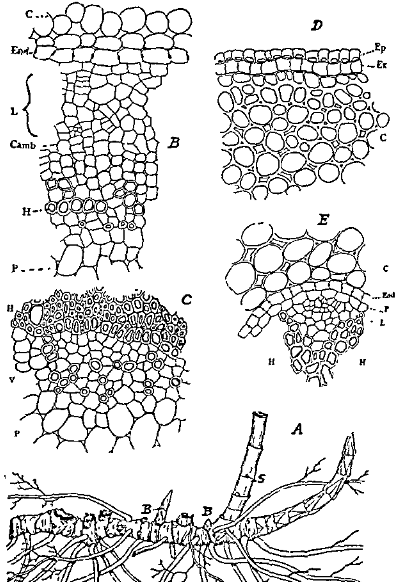


FIG. 329 —Leptandra: *A*, rhizome showing the roots (*R*), buds (*B*), and the base of an aerial stem. *B*, Transverse section of inner portion of a stolon: *C*, Cortex; *End*, endodermis, *L*, a deep strand of phloem having small sieve groups and thin-walled parenchyma, *Camb*, cambium, *H*, primary tracheæ bordering on the pith (*P*). *C*, Transverse section of part of the stele of the main rhizome: *H*, the secondary xylem, showing numerous thick-walled wood fibers and a singl[illegible] outer portion of a root *Ep*, epidermal cells havin[illegible] rtex. *E*, Transverse section of a portion of [illegible]; *P*, pericambium, *L*, phloem; *H*, xylem. (After Holm.)

0 4 per cent

STANDARDS.—Leptandra contains not more than 5 per cent of attached stem-bases and not more than 2 per cent of other foreign organic matter and yields not more than 6 per cent of acid-insoluble ash

USES AND DOSE.—Leptandra is a cathartic and an emetic. Average dose, 1 gm

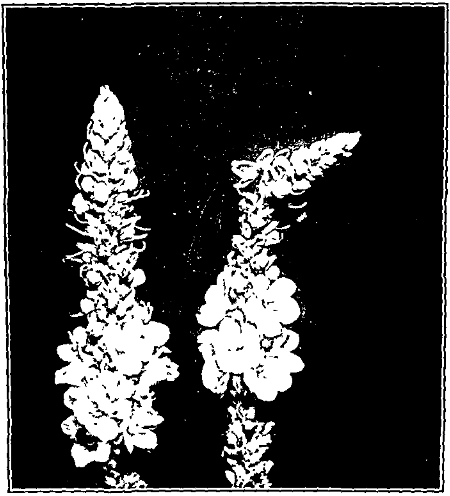


FIG. 330 —*Verbascum phlomoides.* Flowering tops of plants grown in Medicinal Plant Garden, University of Minnesota

Verbasci Folia or Mullein Leaves (N F. 1916 to 1936) is the dried leaf of *Verbascum thapsus*, a biennial herb naturalized from Europe and growing in fields and waste places in the eastern and central United States, often becoming a common weed. The leaves are gathered during summer, at the time of flowering of the plant, and carefully dried.

The leaves are elliptical, ovate or obovate, short petiolate, from 6 to 60 cm in length and 2 5 to 15 cm in breadth, with an acute or rounded apex, a dentate margin, decurrent base, narrowed into the petiole; pale grayish green and

densely woolly-hairy ... out; very thick and rather rough; inodorous; ... bitter.

... he powder are the branched multicellular hairs, which consist of an upright, uniseriate main axis of 2 to 8 cells, from which whorls of branch cells arise at the joints, the individual cells being from 150 to 600 microns in length and frequently containing air; glandular hairs 2-celled, ... ving a nearly spher- ... y undulate, stomata ... 3 to 5 neighbor cells ... cilage; a trace of a volatile oil, and from 1 to 2 per cent of resin, part of which is soluble in ether. Total ash about 10 per cent; acid-insoluble ash 1.8 per cent.

Mullein leaves are demulcent and emollient.

Verbasci Flores or Mullein Flowers (N. F. 1916 to 1936) consists of the dried corolla with adhering stamens, of *Verbascum phlomoides* and *V. thapsiforme*, biennial herbs indigenous to central and southern Europe and western Asia. The former is ... ucky and resembl... ly decur- rent. ... weather in July or August and carefully dried.

The corollas are zygomorphic, either rotate and about 2 cm. in breadth (*V. thapsiforme*), or somewhat funnel-shaped and about 1.5 cm. in breadth (*V. phlomoides*); golden-yellow when fresh, becoming yellowish brown on drying; dorsal surface pubescent, the lobes being ovate, the 2 upper being smaller than the 3 lower lobes; stamens inserted on the corolla, unequal, the 2 upper being longer and glabrous, while the 3 lower are smaller, the filaments being very pubescent; odor distinct, sweet; taste mucilaginous and sweet.

Mullein flowers contain invert sugar, 10.4 per cent; mucilage; volatile oil, a glucosidal coloring principle; cane sugar, and total ash about 6.5 per cent, with about 1 per cent of acid-soluble ash.

The drug is a demulcent and pectoral.

PEDALIACEÆ, OR SESAME FAMILY

This is a family comprising 16 genera and about 60 species of annual or perennial hairy herbs having simple leaves, usually opposite except that the apical ones are occasionally alternate. The flowers are irregular, pentamerous. The fruit is a capsule, a drupe or rarely a one-seeded nut and the seeds are usually exalbuminous.

The plants are mostly tropical. Histologically they exhibit glandular hairs with heads which are invariably divided by vertical walls only; calcium oxalate, when present, is usually in the form of small solitary crystals.

SESAMUM

Sesamum Seed or Sesame Seed is the seed of one or more cultivated varieties of *Sesamum indicum* Linné. ... *indicum* ...

Sesamum is from the Greek s...

The seeds are small, flatten... yellow or reddish brown; taste s... of fixed oil, 22 per cent o... merica are nutritious and form ... ned by they are used like poppy expression.

Sesame Oil, Teel Oil or Benne Oil (U. S. P. 1820 to 1905; N. F. 1926 to 1947; U. S. P. 1947 to date) is a fixed oil obtained from the seed of one or more cultivated varieties of *Sesamum indicum* Linné.

DESCRIPTION.—Sesame oil is a pale yellow liquid, almost odorless, and with a bland taste. Consult the U. S. Pharmacopœia for constants and tests.

CONSTITUENTS.—Sesame oil contains about 75 per cent of olein. Other con- [illegible] stearic, and myristic acids. It [illegible] cottonseed oil.

[illegible] demulcent and emollient.

[illegible] Benne or Sesame Leaves (U. S. P. 1831 to 1882) are the fresh [illegible] é. The leaves are long-petioled, the leaf lamina up to 12 cm. long, ovate or lance-oblong, rather acute apex, entire or toothed or lobed or even with distinct leaflets. The taste is very mucilaginous. Mucilage is the important constituent, for the drug is used principally as a demulcent and to prepare a demulcent drink.

PLANTAGINACEÆ, OR PLANTAIN FAMILY

This family includes 203 species of which 200 belong to the genus *Plantago*. The plants are annual or perennial herbs widely distributed throughout the temperate zone. The flowers have 4 sepals and 4 stamens, the corolla also showing 4 divisions. The fruit is a 2-celled pyxis. The family is characterized by glandular hairs, the heads of which, as in the *Labiatæ* and *Verbenaceæ*, are mostly divided by vertical walls only, the stomata resemble those of the caryophylleous type; calcium oxalate is absent and medullary rays are not present in the wood, even in shrubby species. The formation of cork is superficial.

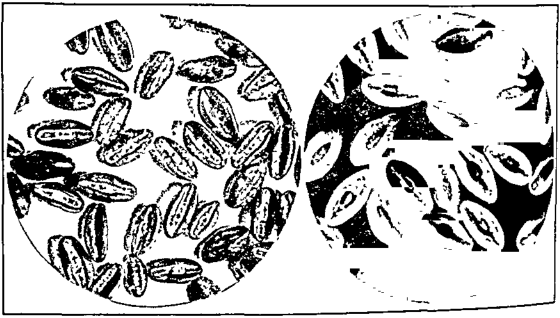
PLANTAGO

Plantago Seed, Psyllium Seed or Plantain Seed (N. F. 1936 to date) is the cleaned, dried, ripe seed of *Plantago Psyllium* Linné, or of *Plantago indica* Linné (*Plantago arenaria* Waldstein et Kitaibel), known in commerce as Spanish or French Psyllium Seed; or of *Plantago ovata* Forskal, known in commerce as Blond Psyllium or Indian Plantago Seed. *Plantago* is from the Latin, meaning sole of the foot and refers to the shape of the leaf; *psyllium* is from the Greek, meaning flea in reference to the color, size and shape of the seed (Fleaseed), *arenaria* is from the Latin *arena*, meaning sand, and refers to the sandy habitat of the plant; *ovata* refers to the ovate shape of the leaf.

Plantago psyllium is an annual, caulescent, glandular, pubescent herb native to the Mediterranean countries and extensively cultivated in France, which country today yields the bulk of our imports of Psyllium seed. *Plantago ovata* is an annual acaulescent herb native to Asia and the Mediterranean countries. The plant is extensively cultivated in India.

In France, planting is done in March, and when the seeds are about three-quarters mature, in August, the field is mowed about dawn, when the dew is heaviest, to prevent scattering of the seed. The plants, partially dried in the sun, are threshed, the seed cleaned and bagged and

allowed to fully dry. In Europe the seed have been a domestic remedy since the sixteenth century, but only since 1930 has it been extensively used in America as a popular remedy for constipation.



A B

Fig 331 —Psyllium Seed: *A*, French Psyllium Seed (*Plantago psyllium*), *B*, Indian Plantago Seed (*Plantago ovata*). (Photo by R. S. A)

Fig 332.—Psyllium Seed Husks. The mucilaginous layer of the seed coat separated from blond psyllium seed. (Photograph by P. D. Carpenter)

Description —The seed of *P. psyllium* is ovate to ovate-elongate, concavo-convex; mostly from 1.3 to 2.7 mm. in length, rarely up to 3 mm, and from

0.6 to 1.1 mm in the margin, very glos)ove nearer the broade the length of the seed and representing the embryo lying beneath the seed coat; the concave ventral surface with a deep cavity, in the center of the base of which is an oval white hilum.

Seed of *P. indica*, ovate-oblong to elliptical, concavo-convex; from 1.6 to 3 mm. in length, and from 1 to 1.5 mm. in width; externally moderate yellowish brown to dark brown, occasionally somewhat glossy, often dull, rough, and

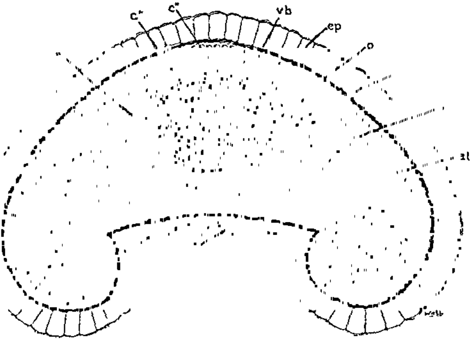


Fig. 333.—*Plantago psyllium.* Median transverse section of the seed showing a seed coat with large epidermal cells (*ep*) whose radial and outer walls break down to form mucilage when brought into contact with water, and a brown pigment layer (*p*) of more or less collapsed cells, a broad endosperm (*e*) having a single outer row of thick-walled palisade cells (*pa*) and irregular inner endosperm cells (*ee*) with thick reserve cellulose walls. The straight embryo lies in the center of the endosperm, the two cotyledons (*c'*, *c''*) being seen in the median transverse section. Three vascular bundles (*vb*) (plerome bundles) extend longitudinally through each cotyledon. The cells of both embryo and endosperm contain fixed oil and aleurone grains (*al*), the latter being rounded, oval or irregular in shape and about 4 microns in diameter. A portion of the raphe (*r*) often remains attached to the seed. Sections of the seeds of *Plantago indica* and of *Plantago ovata* exhibit a similar structure except that in the latter there is no pigment in the seed coat. (Drawing by F. H. Wirth.)

Seed of *P. ovata* broadly elliptical to ovate, boat-shaped; from 2 to 3.5 mm.

the National Formulary.
10 per cent when calculated as pentosans
an (aleurone). Total ash about 3 per cent.

STANDARDS AND TESTS.—Plantago seed contains all of its natural mucilage and not more than 0.5 per cent of foreign organic matter. It yields not more than 4 per cent of total ash and not more than 1 per cent of acid-insoluble ash

When the seed is placed in water the radial and outer walls of the epidermal cells swell to form layers of mucilage about the seed (see Fig. 334). The following test for quality has been devised:

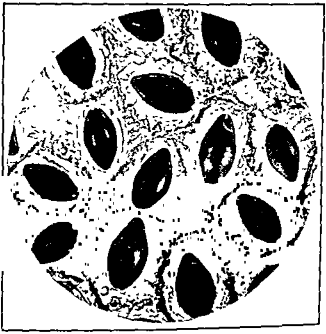


FIG. 334.—Seeds of *Plantago psyllium* placed in water showing the swelling of the mucilage (Photo by R. S. A.)

Place 1 gm of plantago seed in a 25 cc. graduated cylinder, add water to the 20 cc mark and shake the cylinder at intervals during twenty-four hours; allow the seeds to settle for twelve hours and note the total volume occupied by the swollen seeds. the seeds of *Plantago psyllium* occupy a volume of not less than 14 cc., those of *Plantago ovata* not less than 10 cc. and those of *Plantago indica* not less than 8 cc.

USES AND DOSE.—Plantago seed is a laxative due to the swelling of the mucilaginous seed coat, thus giving bulk and lubrication. The seeds should be taken with considerable water. Average dose, 8 gm.

Metamucil (NNR) is a mixture contai... about 50 per cent of powdered ... ovata) mucilaginous portion (outer epidermis) of ...t, and powdered anhydrous dextrose, wit... ...nd monobasic potassium phosphate 0 25 per cent, ... of the seed coat is benzyl benzoate 0.04 per cent. The mucilaginous layer ... as "psyllium separated by ... s an seed husks" ... m, adjunct in t... one to three times a day.

RUBIACEÆ, OR MADDER FAMILY

This is a large family of about 380 genera and 4600 species, most abundant in tropical regions but having representatives in nearly all

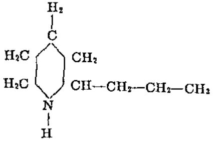
parts of the world. They vary from herbs to trees; the leaves are usually opposite, stipulate and possess entire margins; the flowers are perfect, the corollas being gamopetalous and of a variety of forms; and the fruit is a capsule, berry or drupe. Among the anatomical features the following are the more prominent. The secretory elements are of a number of forms: (*a*) glandular hairs, consisting of several rows of cells, may occur on the stipules; (*b*) the epidermal cells occasionally contain a resinous secretion; (*c*) cells containing resin are sometimes present in the mesophyll; (*d*) secretory cells having a brownish content are found in the leaves of a number of genera and are probably widely distributed; (*e*) elongated secretory sacs have been observed in *Cinchona*, *Cascarilla* and other genera; and finally (*f*) a group of secretory cells tending to form internal glands. The fibrovascular bundles are collateral; the walls of the tracheæ have either simple pores or scalariform perforations, and the wood fibers usually possess bordered pores or occasionally simple pores. Calcium oxalate is secreted in a great many different forms. The neighbor cells of the stomata are arranged parallel to the pores. Non-glandular hairs are either unicellular or uniseriate.

ALKALOIDS

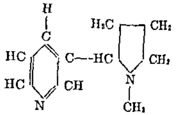
At various places throughout the text it has been thought profitable to introduce brief discussions relative to groups of drugs based upon their active constituents. Since the Family *Rubiaceæ* is rich in alkaloids, a discussion of that group is introduced at this point It is quite impossible to formulate a definition for an alkaloid that would on the one hand limit the substances usually included in this category and on the other hand exclude those substances not usually considered as alkaloids One of the most common definitions states that an alkaloid is "a nitrogenous base of plant origin having marked physiological action." This is quite in error since some of the alkaloids are not necessarily basic in reaction and many [illegible] action All alkaloids contain on [illegible] true of the proteins. While it i [illegible] from plants, there are substances of animal origin that from any chemical reasoning certainly ought to be included with the alkaloids. A case in point includes ephedrine (of plant origin) and epinephrine (of animal origin) both of which are quite similar in chemical constitution. The best that can be said is that alkaloids are nitrogenous, they are usually of plant origin, frequently basic in character and often have a definite physiological action.

Alkaloids usually contain one nitrogen atom although some like ergotoxine may contain up to five. The nitrogen may exist as a primary amine ($R-NH_2$), a secondary amine as such (R_2NH) or cyclic, a tertiary amine as such (R_3N) or cyclic or a quaternary ammonium hydroxide as such (R_4N-OH) or cyclic. These forms of nitrogen linkage are basic and account for the common basic nature of the alkaloids Acid amides (neutral) and acid imides (acid) may also be found in the alkaloids.

and (4) derivatives of both pyridine and pyrrolidine including nicotine from tobacco.



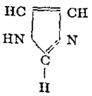
Coniine



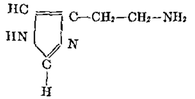
Nicotine

D. The Glyoxaline Group:

Imidazole (glyoxaline) is the principal nucleus in histamine from ergot and pilocarpine from pilocarpus (see formula in the U. S. Pharmacopœia).



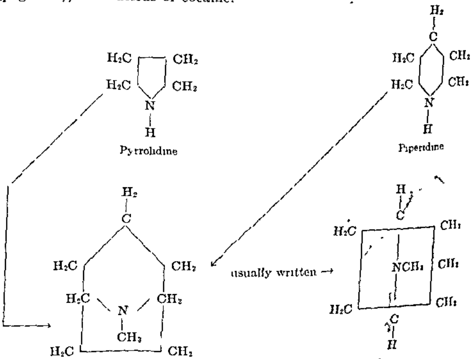
Imidazole



Histamine

E. Alkaloids With Condensed Pyrrolidine and Piperidine Rings:

Tropane is formed when pyrrolidine and piperidine are condensed Closely related to tropane are tropine (page 554), the principal nucleus of the solanaceous alkaloids, atropine, hyoscyamine, hyoscine and belladonnine, and ecgonine (page 366), the nucleus of cocaine.



Pyrrolidine Piperidine

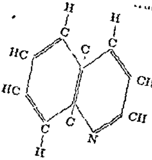
Tropane usually written → Tropane

F. Derivatives of Quinoline:

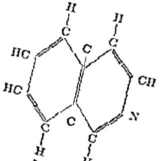
Alkaloids containing quinoline as the principal nucleus include anemonine from *Anemone thalictroides*, galipine from Angostura bark (*Galipea officinalis*) and the cinchona alkaloids, quinine, quinidine, cinchonine and cinchonidine. (See the U. S. P. and N. F. for structural formulæ.)

G Derivatives of Isoquinoline:

Alkaloids cont... (1) papaverin... group, and (2) ... (See U. S. P. a... ...ructural formulæ) ...rastine, berberine and canadine ... of the opium



Quinoline



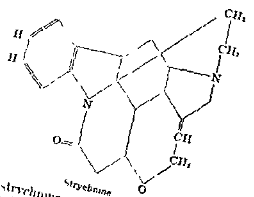
Isoquinoline

H. Phenanthrene:

The opium alkaloids, morphine, codeine and thebaine have a phenanthrene nucleus (See U S Pharmacopœia for structural formula)

I. Indole Derivatives.

Certain alkaloids upon distillation with zinc dust yield indole. It is natural therefore to assume that they possess an indole ring as part of their structure Strychnine and brucine from nux vomica and physostigmine from physostigma belong to this group Strychnine and brucine contain in addition a quinoline nucleus and many authors classify them in the quinoline group The following formula for strychnine is now generally accepted

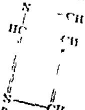


Strychnine

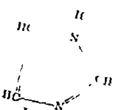
Brucine is dimethoxystrychnine, in which the methoxy groups replace the two hydrogen atoms indicated in the above formula For the formula of physostigmine see the U S Pharmacopœia

J The Purine Bases

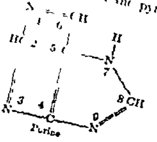
The purine nucleus is constructed by a "condensation" of the pyrimidine and imidazole (glyoxaline) nuclei



Pyrimidine



Imidazole



Purine

Xanthine is 2,6 dioxypurine; caffeine is 1,3,7 trimethylxanthine, theophylline is 1,3, and theobromine 3,7 dimethylxanthine. These alkaloids are found in coffee, tea, cacao, kola, maté and guarana.

K. **Alkaloids of Unknown Constitution:**
The constitution of a number of alkaloids has not as yet been definitely established. Among
jervine and protojer
lobeline from lobelia
and many others.
hemical classification some alkaloids do not fall
above groups while others can be classified in
more than one group.

CINCHONA

Cinchona, Cinchona Bark or Peruvian Bark (U. S. P. 1820 to 1942; N. F. 1942 to date) is the dried bark of the stem or of the root of *Cinchona succirubra* Pavon et Klotzsch or its hybrids, known in commerce as Red Cinchona; or of *Cinchona Ledgeriana* (Howard) Moens et Trimen, *Cinchona Calisaya* Weddell, or hybrids of these with other species of *Cinchona*, known in commerce as Calisaya Bark or Yellow Cinchona

Cinchona Flava, Yellow Cinchona, Calisaya Bark or Yellow Bark (U. S. P. 1820 to 1894, as Cinchona 1894 to 1948) is the dried bark of *Cinchona Calisaya* Weddell.

Cinchona Pallida, Pale Cinchona, Pale Peruvian Bark, Loxa Bark or Crown Bark (U. S. P. 1820 to 1882, as Cinchona 1882 to 1916) is the dried bark of *Cinchona officinalis* Hooker.

Cinchona Rubra, Red Cinchona, Red Peruvian Bark or Red Bark (U. S. P. 1820 to 1926, as Cinchona 1926 to 1948) is the dried bark of *Cinchona succirubra* Pavon.

Cinchona was named in honor of the Countess of Chinchon, wife of the Viceroy of Peru; *succirubra* is Latin meaning "red juice;" *calisaya* is the Spanish and Indian name in Peru for the bark of a tree; *ledgeriana* is named in honor of Charles Ledger who introduced *Cinchona* into the East Indies. The plants are trees indigenous to the Andes of Ecuador and Peru at an elevation of 3000 to 9000 feet, and are cultivated in the East Indies and India. There are 36 known species and hybrids of *Cinchona*.

Just before the Second World War, Java supplied over 90 per cent of the world consumption of this important drug. The Japanese cut off this supply from the world, and several valuable antimalarial agents were developed during the war to take the place of cinchona. Also cultivation of cinchona trees was undertaken in several other countries in Central and South America.

Cultivation gives opportunity to select seed from plants producing high-quality bark; also to hybridize one choice strain with another. Thus, *Cinchona ledgeriana-calisaya* produces a higher yield of alkaloids than either of the parent species. Selected seed planted in seed beds give plants suitable for transplanting when two years old. They are planted in the fields but a few feet apart; the stems tend to grow tall, lower branches tend to die and drop off, the tree crowns are

close together, hence shade the trunks, and shade is favorable to the production of quinine. Trees six to nine years old possess the maximum amount of alkaloids in the bark; such trees have produced but a thin cork (the cork is inert); they can be easily pulled with tractors; the fresh bark of trunk and roots is easily removed by hand; when well dried it may have an alkaloidal content three times as great as the bark from an old tree will yield

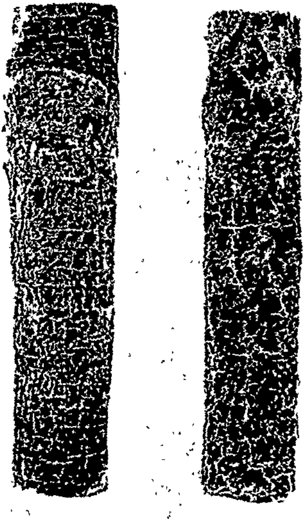


FIG. 335. Typical specimens of *Cinchona succirubra* bark from Java. (From a photograph by Powers-Weightman-Rosengarten Co., Philadelphia.)

The bark of the stem is usually used in the manufacture of galenicals, while the root bark is used for the extraction of the alkaloids, especially quinine.

For the history of Cinchona, which is lengthy and filled with romance, the student should read Lloyd's History of Pharmacopœial Drugs The natives of Peru seem to have been unacquainted with the properties

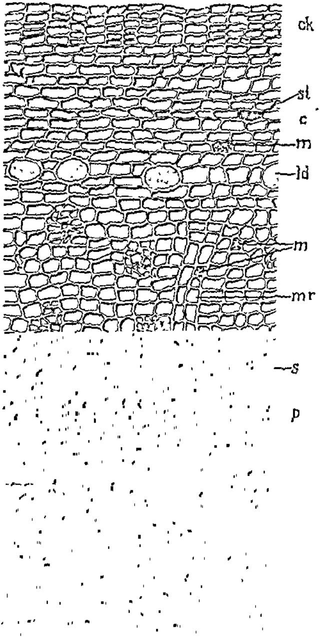


FIG. 336 —*Cinchona calisaya* transverse section of the bark showing a cork (*ck*) of numerous layers of rectangular cells, a cortex containing starch (*st*) and occasional microcry ... ducts (*ld*) ... rays (*mr*) ... isolated or ... bast fibers ... Fried.) ... awing by Edward

of the drug, its bitter taste rather inspiring them with fear. Although Peru was discovered in 1513 it is not until 1638 that the story begins. Tradition has it that an Indian, overcome with fever was *forced* to

drink stagnant water in which fallen cinchona trees had macerated for some time. An Indian medicine man near Loxa taught a Jesuit missionary the use of the drug, who in turn taught others, among them Canizares the *corregidor* of Loxa. Canizares sent the bark to Juan de Vega, who at that time was treating the Countess Ana de Osorio, wife of the Count of Chinchon, and Viceroy of Peru, for tertian fever. The Countess recovered and shortly thereafter introduced the bark into Europe. The use of cinchona was further spread through the efforts of the Jesuit Order. For the next half century or more Europe seethed with a controversy over cinchona, the drug being widely condemned on

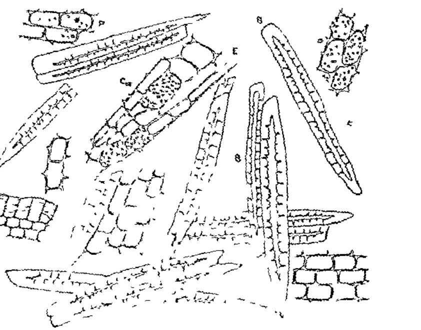


FIG. 337. Powdered Cinchona: brown; bast fibers (*B*) spindle-shaped, yellowish, 0.300 to 1.350 mm. in length and 50 to 150 microns in width, with thick, strongly lignified, lamellated walls having slit-like, oblique pores; sphenoidal microcrystals (*Ca*) numerous but very minute; parenchymatous cells, (*P*) with reddish brown tannin masses; starch grains relatively few, either single or 2- to 5-compound, the individual grains from 3 to 20 microns in diameter; sieve tissue (*E*) and cork (*K*) of small rectangular, thin walled cells with brown contents.

one hand and praised on the other. Early names for the drug were Countess Bark, Jesuit's Bark and Peruvian Bark. It is interesting to note that Linnaeus, in naming the genus, desired to honor the Countess but omitted the second letter in the name, which error has continued to the present day. The tree yielding cinchona bark was unknown until 1737. In 1854 the Dutch began its introduction into Java and in 1860 the English introduced it into India.

DESCRIPTION. In fragments, coarse powder or in double quills from 15 to 20 mm. in diameter, bark 2 to 8 mm. in thickness, outer surface weak reddish brown to moderate yellowish brown, with grayish patches of foliaceous lichens on the stem bark, more or less roughened with corky ridges or protuberances

and with transverse fissures, the latter rarely numerous or much intersected and having their sides sloping (red cinchona), or with numerous intersecting transverse and longitudinal fissures having nearly vertical sides (yellow cinchona); inner surface reddish brown, distinctly striate; fracture short and granular in the periderm, but in the inner bark with projecting bast fibers; odor distinct; taste astringent and very bitter.

Structure and Powder.—See Figures 336, 337 and the National Formulary.

Constituents.—The alkaloids are chiefly formed in the parenchyma cells of the middle layers of the bark. Cinchona contains some 25 closely related alkaloids, of which the most important are quinine, quinidine, cinchonine and cinchonidine, the average yield being 6 to 7 per cent, of which from one-half to two-thirds is quinine in the yellow barks, whereas in the red barks, cinchonidine exists in greater proportion; specimen pieces have yielded as high as 18 per cent of total alkaloids. Other constituents of cinchona are quinic acid, from 5 to 9 per cent, which forms colorless rhor
consisting of golden crystals of quinone on
and sulfuric acid; quinovin, an amorphous,
0.11 to 1.74 per cent, cinchotannic acid, from 2 to 4 per cent, which decomposes into the nearly insoluble cinchona red, occurring in red barks to the extent of 10 per cent, considerable starch. Total ash, about 2.55 per cent, with 0.15 per cent of acid-insoluble ash. The red color in cinchona bark is due to an oxydase similar to that which causes the darkening of fruits when cut. If the fresh bark is heated in boiling water for thirty minutes and then dried it does not become red.

Standards and Tests.—See the National Formulary.

In commerce, cinchona bark is priced very largely on the basis of its total alkaloid content and frequently on its quinine content.

Uses and Dose.—Cinchona is a tonic, an antiperiodic and a febrifuge. It frequently produces derangement of the sense of hearing, sometimes, too, that of sight. Average dose, 1 gm.

Cinchona officinalis yielding **Cinchona Pallida Bark** is a shrub indigenous to Ecuador, and is the species first discovered. It is cultivated in nearly all the large cinchona plantations. The bark is usually in small, dark-colored quills. It contains up to 4 per cent of total alkaloids, one-half to one-third of which is quinine.

Cuprea Bark is obtained from *Remijia purdieana* and *R. pedunculata*, of central and southern Colombia. It has a copper-red color, is hard, compact and heavy, contains numerous transversely elongated stone cells and 2 to 6 per cent of alkaloids, of which one-third may be quinine. Cinchonidine has never been isolated from this bark. Cuprea bark also contains caffeate of quinine and caffeic acid, of which there is about 0.5 per cent and which closely resembles the same acid obtained from caffeotannic acid in coffee.

The Cinchona Alkaloids

Cinchonidine, $C_{19}H_{22}ON_2$, stereoisomeric with cinchonine, is an alkaloid from cinchona, about 0.4 p ... to 2 per cent from native bark. It occurs in wh ... luble in water but readily so in alcohol, ... ommercial salts of cinchonidine are listed.

Cinchonidine Sulfate (U. S. P. 1882 to 1936; N. F. 1936 to date) occurs in white, silky, acicular crystals, efflorescent in dry air and darkening when exposed to light. It is an antiperiodic, a bitter tonic, etc., but weaker than quinine sulfate. It is used as an antirheumatic for neuralgia, sciatica and rheumatism; as an antispasmodic in heroic doses for whooping cough, and as a tonic.

Cinchonine, $C_{19}H_{22}ON_2$ (U. S. P. 1882 to 1905) is an alkaloid stereoisomeric with cinchonidine. It was discovered in 1811 by Gomez in cinchona and is present in from 0.3 to 1 per cent. It occurs as white to yellow, bitter needles or prisms, and should be protected from light. Ten of its salts are listed commercially.

Cinchonine Sulfate (U. S. P. 1863 to 1926; N. F. 1926 to date) occurs as colorless, lustrous, very bitter crystals, permanent in air, but affected by light. It is rather soluble in water, alcohol and chloroform. It is used like quinine sulfate, though somewhat weaker.

Quinidine, $C_{20}H_{24}O_2N_2$ (N. F. 1916 to 1936) is a stereoisomer of quinine, and present in cinchona barks to the extent of 0.25 to 1.25 per cent. It occurs as white crystals or crystalline powder, slowly darkening on exposure to light. It is readily soluble in alcohol, methanol, ether, chloroform and dilute acids. Eight salts of quinidine are listed commercially.

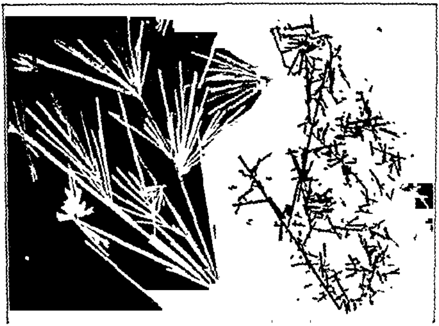


Fig. 338.—Quinine sulfate: long orthorhombic needles from a dilute alcoholic solution.

Quinidine Sulfate (U. S. P. 1882 to 1905, 1936 to date) occurs in white, very bitter, fine crystals, readily soluble in water, alcohol, methanol and chloroform. It is an antiperiodic and protoplasmic poison, it is used particularly to inhibit auricular fibrillation, in an average dose of 0.2 gm.

Quinine, $C_{20}H_{24}O_2N_2$ (U. S. P. 1882 to 1942, N. F. 1942 to date) occurs as white, odorless, bulky, very bitter crystals or crystalline powder, it darkens on exposure to light, and effloresces in dry air. It is freely soluble in alcohol, ether and chloroform, but slightly soluble in water. Fifty-four of its salts are commercially listed.

Quinine Sulfate (U. S. P. Impure quinine sulfate, 1831 to 1842, Pure, 1842 to date) occurs in white, odorless, bitter, fine needle-like crystals;

usually lusterless. It becomes brownish on exposure to light. It readily loses some of its 8 mols of crystallization water when exposed to dry air. It is not readily soluble in water, alcohol, chloroform or ether.

The drug is a protoplasmic poison, especially for protozoa; a specific antimalarial; an antiseptic; an antipyretic and a tonic.

The following quinine salts have been recognized in the U. S. Pharmacopœia or the National Formulary:

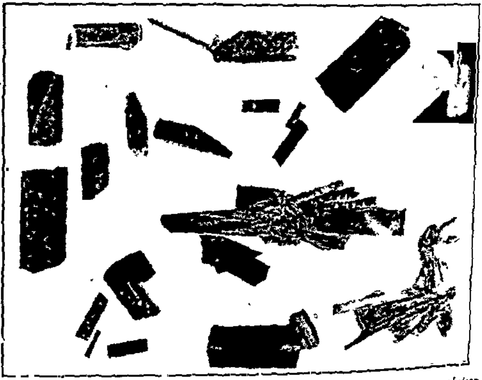


FIG. 339.—Cinchonine sulfate orthorhombic crystals from a saturated aqueous solution

Quinine Bisulfate or **Quinine Acid Sulphate** (U. S. P. 1882 to date).

Quinine Dihydrochloride (U. S. P. 1916 to date).

Quinine Ethylcarbonate or **Euquinine** (U. S. P. 1926 to 1947; N. F. 1947 to date).

Quinine and Urea Hydrochloride (U. S. P. 1916 to 1947; N. F. 1947 to date).

Quinine Glycerophosphate (N. F. 1916 to 1926).

Quinine Hydrobromide (U S P. 1882 to 1936; N F. 1936 to date).

Quinine Hydrochloride (U. S. P. 1882 to 1936, N. F. 1936 to 1942; U. S. P. 1942 to date).

Quinine Hypophosphite (N F 1916 to 1926).

Quinine Phosphate (N. F. 1936 to date).

Quinine Salicylate (U. S. P. 1905 to 1926, N. F. 1936 to date).

Impure Quinine Sulfate (U. S. P. 1831 to 1842).

Quinine Sulfate (U. S. P. 1842 to date).

Quinine Tannate (*U. S. P. 1916 to 1936*).
Quinine Valerate (Valerianate) (*U. S. P. 1863 to 1905; N. F. 1916 to 1926*).

Totaquine (U. S. P. 1942 *to date*).

The more readily soluble quinine salts are the Bisulfate, Dihydrochloride, Hydrochloride, and Quinine and Urea Hydrochloride, which are used for intravenous injection. Others, such as Quinine Tannate, are so insoluble in the saliva as to greatly reduce the bitter taste. Some have rather specific uses; such as Quinine Oleate as a preventive of sunburn and *x*-ray burn ... dilute solution in volatile solvents, for moth-proofing fab... is a pronounced antiseptic, especially on th... nervous headaches and hysteria; Quinine a... valuable local anesthetic.

The dosage of quinine salts for the treatment of malaria in adults should never be less than 1 gm. daily, better 1.3 gm. daily, for quartan and malignant malaria, 2 gm. daily should be used. Doses in excess of this are dangerous. *A dosage of 0.1 to 0.3 gm. of quinine daily as a preventive of malaria is considered as unsatisfactory*; malarial protozoa tolerant to quinine tend to develop. Daily doses of 0.2 to 0.4 gm. as a tonic or as an analgesic in the treatment of colds, are used extensively.

Quinine or Quinidine in solution in dilute sulfuric acid show a characteristic blue fluorescence. When 2 or 3 drops of bromine T.S. are added to 5 cc. of an aqueous solution of a quinine or quinidine salt, and this followed by 1 cc. of ammonia T.S., the liquid acquires an emerald green color, due to the formation of thalleioquin, a very characteristic reaction, capable of detecting quinine or quinidine in a dilution of 1 to 20,000.

IPECAC

Ipecac (U. S. P. 1820 *to date*) *consists of the dried rhizome and roots of Cephaelis Ipecacuanha* (Brotero) A. Richard, known in commerce as Rio or Brazilian Ipecac (U. S. P. 1820 to date), or of *Cephaelis acuminata* Karsten, known in commerce as Cartegena, Nicaragua or Panama Ipecac (U. S. P. 1905 to date). Ipecac yields *not less than 2 per cent of the* ether-soluble alkaloids of Ipecac.

Cephaelis is from two Greek words, meaning "head" and "to collect or roll up," referring to the inflorescence, *Ipecacuanha* is Portuguese from the Brazilian Indian *ipe-kaa-guene*, meaning "a creeping plant that causes vomiting," *acuminata*, refers to the acute apex of the leaf.

The plants are low straggling shrubs with slender rhizomes bearing annulated wiry roots. *C. Ipecacuanha* is indigenous to Brazil and has been cultivated to a limited extent in the Malay States. The commercial supply is from Matto Grosso, Brazil. The drug is gathered during the dry season and dried rapidly in the sun for two or three days. *C. acuminata* is indigenous to the northern portions of Columbia, and up into Panama and Nicaragua. It is exported from Cartegena and Savanilla. Apparently ipecac was used by the South American Indians. The first mention of the drug was by a Jesuit friar in 1601. The drug was introduced into Europe by Le Gras in 1672 and by 1690 was well known in medicine.

DESCRIPTION.—**Rio or Brazilian Ipecac**: roots cylindrical, sharply flexuous or curved, 3 to 15 cm. in length, 1 to 4 mm. in diameter, externally reddish

brown to dark brown, smooth or closely annulated, sometimes transversely fissured, the fissures with vertical sides, occasional rootlets or rootlet scars, portions of the annulated roots or even whole roots may be thin and smooth; bark of thin root about one-ninth of whole diameter, of annulated root about two-thirds of whole diameter, and easily separable from the dark yellow, non-porous, fibrous wood.

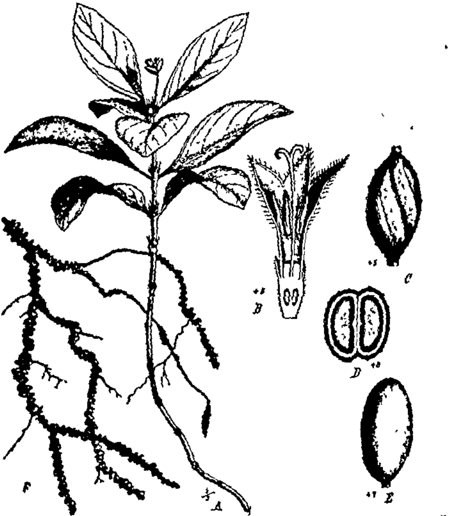


FIG. 340.—Ipecac plant [*Cephaëlis* (*Uragoga*) *Ipecacuanha*]: *A*, flowering shoot; *B*, flower in longitudinal section; *C*, fruit, *D*, fruit in transverse section, *E*, seed, *F*, annulate root. (After Schumann.)

Cartagena Ipecac closely resembles the Rio ipecac, but the roots are uniformly thicker (4 to 7 mm. in diameter), grayish, grayish brown, or reddish brown in color, and the annulations are less pronounced.

Ipecac Stems are usually more slender, 1 to 1.5 mm. in diameter, nearly smooth or longitudinally wrinkled; bark 0.1 mm. in thickness, with bast fibers either si [illegible] Pharmacopœis. [illegible] cent)—emetine, [illegible] which makes up cephaëline and psychotrine, contained chiefly in the [illegible], [illegible] 2.25 per cent, with which the ab[illegible] min; starch about 40 per alk[illegible] 1 per cent. cer[illegible] per cent (about one-third

cephaëline and two-thirds emetine); in Cartagena Ipecac alkaloids total 2.5 per cent or more (about four-fifths cephaëline and one-fifth emetine).

Uses and Dose.—Ipecac is an emetic, an expectorant and (often admixed with opium) a diaphoretic Average dose: emetic, 0 5 gm.; expectorant or diaphoretic, 60 mg

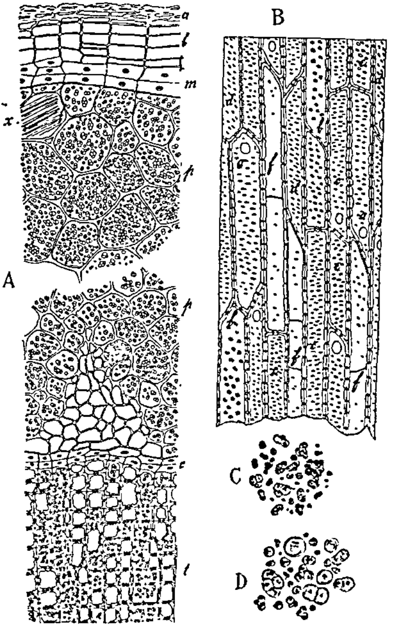
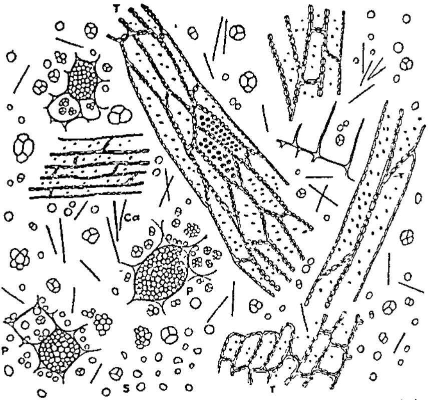


Fig. 311.—Ipecac: *A*, transverse section of Rio Ipecac showing outer layers of cork [illegible]

Emetine or Methyl Cephaëline, $C_{29}H_{40}O_2N_2$, is an alkaloid obtained from Ipecac or prepared synthetically by methylation of cephaëline. It was discovered by Pelletier in 1817. It occurs as a white, amorphous powder, becoming darker on exposure to light. It forms crystalline salts, of which several are commercially listed.



numerous, 2- to 7-com-
microns in diameter,
ids (*T*) having either
w. slightly elongated
mple branch-
r.

Emetine Hydrochloride (U. S. P. 1916 to date) is a hydrated hydrochloride of emetine, containing from 4 to 5 mols of water. It occurs as a white, odorless, crystalline powder, becoming yellowish on exposure to light. It is freely soluble in water or in alcohol.

The drug is an expectorant and an emetic, but it is used principally as an amebicide in amebic dysentery and in pyorrhea alveolaris and other amebic diseases. Expectorant dose, about 3 mg.; emetic dose, 10 mg.; amebicide dose, intramuscular, daily, 60 mg., for not to exceed ten days.

Cephaëline, $C_{28}H_{38}O_4N_2$, is an alkaloid obtained from Ipecac, and occurs ... exposure to light. It is insoluble ... oform. ... ht and readily soluble in water. It is ... more active than emetine and possibly ...) mg

Psychotrin ... obtained from Ipecac, occurs as white to ...

deep blue.

Allied Plants.—Several plants of *Rubiaceæ* and of other families produce roots that may resemble Ipecac and that possess emetic properties, but none of them contain emetine.

Undulated Ipecac is the dried root of *Richardia scabra* (Houst.) Linné (*Richardsonia scabra* Linné), a plant growing in tropical and subtropical America, with an undulate, annulate root, the bark of which is nearly as thick as the yellowish, soft wood. It has simple and compound starch grains from 20 to 40 microns in diameter.

Striated Ipecac is the dried root of *Cephaelis emetica*, a plant growing in South America, with a dark purplish brown root, with a few transverse fissures and a thick bark in which starch is absent.

American Ipecac or Gillenia (U. S. P. 1820 to 1882) and **Indian Physic or Gilleniæ Trifoliatæ Radix** (U. S. P. 1831 to 1842) are the roots of *Gillenia stipulata* and *G. trifoliata* respectively (Fam. *Rosaceæ*). The roots somewhat resemble ipecac root; the American Ipecac root has thinner bark with numerous resin cells, and Indian Physic root is not annulate.

Euphorbia Ipecacuanha or Ipecac Spurge (U. S. P. 1820 to 1882) and **Euphorbia Corollata, Purging Root or Emetic Root** (U. S. P. 1820 to 1882) are the dried roots of *Euphorbia Ipecacuanha* and *E. corollata* respectively (Fam. *Euphorbiaceæ*). The

Ipecac root.

Ionidium,

dried root of

larger and has thinner bark than annulate Ipecac. The roots of other *Hybanthus* species, the root of *Anchictea salutaris* of Brazil and the rhizome of *Viola odorata* have emetic principles.

Bastard Ipecac is the dried root of *Asclepias currassavica* Linné (p. 513).

Indian Ipecac is the dried root of *Tylophora indica (asthmatica)*.

Goanese Ipecac is the dried root of *Naregamia alata* (Fam. *Meliaceæ*) from the East Indies. The root contains starch, calcium oxalate rosettes, orange-red secretion cells and the alkaloid naregamine. It is strongly emetic.

GAMBIR

Gambir or Pale Catechu (U. S. P. 1905 to 1936; N. F. 1936 to date) is the dried aqueous extract prepared from the leaves and twigs of *Uncaria Gambir* (Hunter) Roxburgh. *Gambir* is the native Malaysian name of the plant.

The plant is a climbing shrub growing in the Malay States and in the East Indies. The natives gather the leaves and twigs and extract them by boiling with water. The aqueous extract is evaporated in tubs and when sufficiently thick is cut into cubes and frequently dried over fires. Most of the drug is produced in Singapore, Bintang and British North Borneo. Gambir is one of the substances known as catechu (Malay *cate*, a tree; *chu*, juice) which were first described about the sixteenth century. The catechu of Barbosa (1514) was probably black catechu. The first account of gambir seems to be that of a Dutch trader in 1790. Its known production in Singapore dates from 1820.

DESCRIPTION.—Usually in more or less porous, dull, irregular cubes, up to ... able; inter-

... rous; taste ... stals up to ... the undis-solved residue may occur a few leaf fragments, with non-glandular, thick-wa ... fro ... in ... which crystallizes in silky needles; gambir-fluorescein; catechu red; quercetin; ash, about 3 per cent.

STANDARDS AND TESTS.—Gambir yields not less than 60 per cent of alcohol-soluble extractive, not less than 70 per cent of water-soluble extractive, and not more than 1 per cent of acid-insoluble ash.

Macerate 1 gm. of powdered gambir with 50 cc. of distilled water for one hour, filter; separate portions of this filtrate give an intense green color with dilute ferric chloride T.S. and no precipitate with cupric sulfate T.S. (*catechu-tannic acid*).

Extract powdered gambir with alcohol and filter; to the filtrate add sodium hydroxide T.S., and, after shaking, a few cc. of petroleum benzin; upon standing, the benzin layer ... (gambir-fluorescein)

Wet a match stick ... mpart but a slight ... nickly remove it, a ... (catechin).

USES AND DOSE.—Gambir is an astringent. It is also employed ... and as a mordant in dyeing. Average dose, 0 5 gm.

Mitchella or Squaw Vine (N. F 1926 to 1947) is the dried plant of *Mitchella repens* Linné. The plant is a creeping shrub with evergreen leaves, and with stems trailing on the ground, and is common in woods throughout the eastern and central United States Commercial supplies of the drug come from Virginia and the Carolinas and to some extent from New England. The drug is said to have been employed by the American Indians as a parturient

The drug is in loosely matted masses consisting of much branched rhizomes with their fine roots together with the stems and leaves; rhizomes light yellowish to dark brown, filiform, with slender fibrous roots; stems quadrangular or flattened, light green, with surface finely striated, bearing opposite leaves; leaves green, coriaceous, rounded-ovate, entire, up to about 2 cm. in length and with a short petiole, upper surface smooth, dark green with prominent midrib and veins, lower surface smooth, light green and somewhat shiny.

The powder is light grayish green; odor faint; taste slightly bitter; numerous ... fragments ... icrons ... culate ... s con- ... pheroidal or ... s a saponin. ... dose, 2 gm ... dried ripe ... of the seed coat

Caffea Tosta or Roasted Coffee (N F. 1910 to 1936) is coffee roasted until it is a dark brown color and the characteristic aroma is developed.

The plants are small evergreen trees or shrubs with lanceolate, acuminate, entire, slightly coriaceous, dark green, short-petiolate leaves, which are partly

united with the short interpetiolar stipules at the base. The name *Coffea* is from the Turkish *qahıeh* or the Arabic *qahuah*, the name of a beverage. The coffee plant is indigenous to Abyssinia and other parts of eastern Africa and is widely cultivated in tropical countries, notably in Java, Sumatra, Ceylon, and Central and South America, particularly Brazil, over 600,000 tons being produced annually in the latter country. The yield of one tree is between 0.5 and 5 kg.

The fruit is a small, spheroidal or ellipsoidal drupe with two locules, each

are allowed to dry in such a manner as to undergo a fermentation, and after drying, the endocarp is removed. The green seeds are sent into commerce and roasted.

Coffee seed contains from 1 to 2 per cent of caffeine; trigonelline, a non-toxic alkaloid, also found in fenugreek seed; from 3 to 5 per cent of tannin; about 15 per cent of glucose and dextrin; 10 to 13 per cent of a fatty oil consisting chiefly of olein and palmitin; 10 to 13 per cent of proteins; and yields 4 to 7 per cent of total ash, nearly all of which is acid-soluble.

In the roasting of coffee the seeds swell, change their color to dark brown and develop the characteristic odor and flavor. The aroma is due to an oil known as caffeol, a methyl ether of saligenin, and which is developed during the roasting process. The caffeine may be partially sublimed and much of the caffeine of

3 per cent and not more than 5 per cent of total ash, and not less than 10 per cent of fat.

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coffee is
It is of

Coffee Hulls, Sultan or Sacca Coffee is sometimes substituted for coffee. This consists of the outer layer of the pericarp.

beans
tions
ordinary roasted coffee.

ground kernels of the acorns of several species of *Quercus*, which are readily identified by the elongated, more or less swollen, distorted starch grains which have a prominent, elongated cleft in the middle.

Rubia, Madder or Dyer's Madder (U. S. P. 1820 to 1882) is the dried root of *Rubia tinctorium* Linné. The plant is an herbaceous perennial indigenous to the Levant and southern Europe and was formerly cultivated as a dyestuff. The rhizome is creeping, the roots long, cylindrical, wrinkled and brownish red

in color. T
drying, br
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dye, thoug
prepared synthetically.

Madder is used in medicine as an emmenagogue. It has been used as an indicator, orange-red with acids and purple to blue with alkalis.

CAPRIFOLIACEÆ, OR HONEYSUCKLE FAMILY

This is a small family of plants numbering 11 genera and about 340 species, mostly indigenous to the northern hemispheres and of great diversity as regards habit, leaves, flowers and fruits. The cork is usually superficial, except in *Sambucus* and *Viburnum,* where it is formed inside the bast layers. Secondary bast fibers are developed in nearly all of the genera, excepting *Viburnum.* The tracheæ usually possess scalariform perforations; the wood fibers have bordered pores; and the medullary rays are mostly narrow. Internal secretory organs are wanting, except in *Sambucus,* where tannin secretory cells occur. The non-glandular hairs are unicellular, stellate, peltate or tufted. The glandular hairs are of two kinds: (*a*) having a uniseriate stalk and a spheroidal or ellipsoidal secreting summit, as in *Lonicera, Sambucus, Triosteum* and *Viburnum;* or (*b*) peltate, having a unicellular stalk and shield of 3 to 7 cells as in *Diervilla*

VIBURNUM PRUNIFOLIUM

Viburnum Prunifolium or **Blackhaw** (U. S. P. 1882 to 1926; N. F. 1926 to date) is the dried bark of the root or stem of *Viburnum prunifolium* Linné or of *Viburnum rufidulum* Rafinesque. *Viburnum* is from the ancient Latin, possibly meaning "to bind, to tie or to plait" from the flexibility of the branches of some of the species; *prunifolium* means "leaves resembling those of the plum tree." The plant is a shrub or small tree indigenous to the eastern and central United States. Most of the commercial supplies are gathered in western North Carolina and Tennessee. In 1857 Professor John King recommended it as a uterine tonic. The root-bark is more highly esteemed than the bark of the stem and branches.

Description.—Root Bark in quills, transversely curved pieces, or irregular oblong chips, 0 5 to 1 5 mm. in ... brown or, where the cork is removed, brownish red, ... ughened from corky protuberances; inner surfac ... streaks, longitu ... brownish red, inner bark with numerou ... 6 mm. in thickness, externally ... k, inner surface paler, striated; gr ... fracture short but uneven. It should be rossed to the brown middle bark.

Powder.—Light brown to moderate yellowish brown; inodorous, acquiring a valeric acid odor upon aging or exposure to air; taste bitter and astringent; calcium oxalate in rosettes or prisms up to 57 microns in diameter or length; stone cells numerous, up to 260 micr ... length irregular or elongated, often in groups, thick-walled and strongly ... tively few, lignified; starch grains simple or 2- or

STRUCTURE.—Root Bark: See Figure 343 and the National Formulary.

Stem Bark: Similar to root bark, except that excessive borke containing cork and stone cells is found in unrossed old bark, and a few pericyclic fibers are found in young bark.

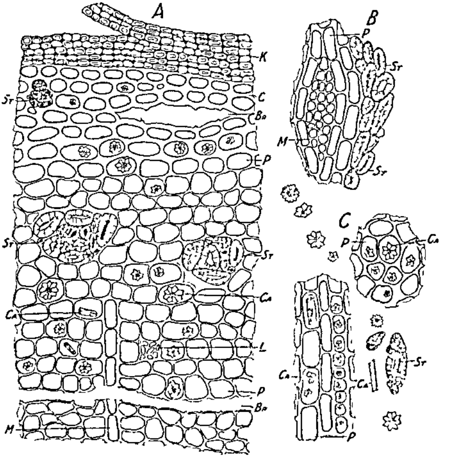


FIG. 343.—*Viburnum prunifolium*. A, transverse section of part of the root bark;

CONSTITUENTS.—Salicylic alcohol (saligenin), the aglycone of salicin, gives a marked uterine sedative action, a pink, alcohol-soluble polymerization product of saligenin is even more markedly active (J. A. Ph. A. 36: 101, 1947). Also a bitter, somewhat resinous principle, viburnin, valeric (viburnic) acid and other organic acids; resin, tannin, calcium oxalate, ash, about 10 per cent.

USES AND DOSE.—Viburnum Prunifolium is an astringent and a tonic. It is also a nervine, a uterine sedative and a diuretic. Average dose, 4 Gm.

ADULTERANTS.—The barks of one or more allied species, especially *Viburnum dentatum* and *Viburnum lentago* may sometimes be substituted for the official bark.

VIBURNUM OPULUS

Viburnum Opulus, High-bush Cranberry Bark or True Cramp Bark (U.S.P. 1894 to 1916; N. F. 1916 to date) is the dried bark of *Viburnum opulus* Linné var. *americanum* (Miller) Aiton. *Opulus* means wealth or riches,

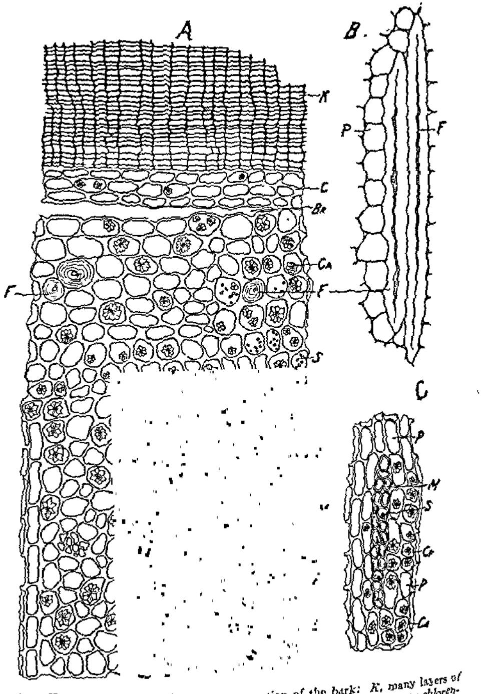


FIG 344.— *Viburnum opulus* A, transverse section of the bark: K, many layers of thin-walled cork cells in older bark, epidermis in young bark, C, parenchyma or chlorenchyma of the cortex containing a greenish yellow amorphous substance, rosette aggregates [illegible] small groups bast
of calcium [illegible]
of sieve, [illegible]
fibers and [illegible]
In older [illegible]
are developed in the phloem (By Haase.)

in reference to the wealth of foliage. The plant is a shrub with nearly erect branches indigenous to the northern United States and southern Canada. Most of the commercial supplies are gathered from plants growing wild in Minnesota, Michigan and Maine. The bark was employed by the Indians as a diuretic.

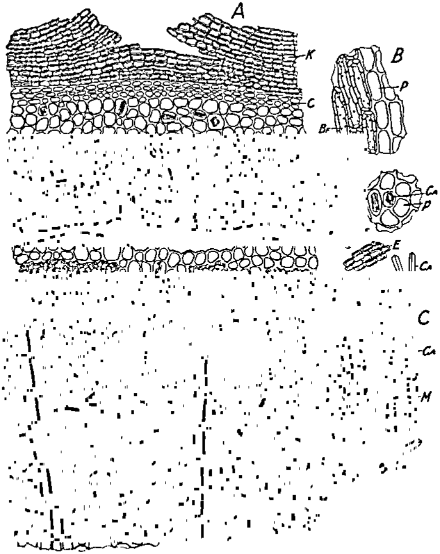


FIG. 315.—*Acer spicatum*: *A*, transverse section of bark showing cork (*K*), a narrow [illegible]

DESCRIPTION. In strips, or occasionally in quills or chip-like fragments, the bark up to 3 mm. in thickness; outer surface of the thinner pieces purple to greenish brown or greenish yellow, sometimes with crooked longitudinal wrinkles

and a few, small brown lenticels; the thicker pieces from light gray and grayish brown to grayish black or black ... fissured or scaly; inner surface fr... oblique or irregular striæ, except ... in thinner bark to short and weal... in thicker bark; the fractured surface with a brownish outer bark, a greenish phelloderm, and pale brown to yellowish inner bark.

STRUCTURE.—See Figure 344 and the National Formulary.

POWDER.—*Pale brown to weak yellowish orange; odor slight, but characteristic, becoming like valeric acid upon aging or, upon trituration with phosphoric acid; taste somewhat astringent and decidedly bitter; parenchyma fragments bearing starch and rosette crystals of calcium oxalate, the latter up to 42 microns in diameter, and a yellowish brown amorphous substance; cork fragments with polygonal, tabular cells, occasionally with lignified walls; stone cells variable in shape, up to 124 microns long and 35 microns thick; occasional primary bast fibers with thick, lamellated somewhat lignified walls; starch grains mostly simple, seldom exceeding 6 microns in diameter.*

CONSTITUENTS.—The constituents resemble those of Viburnum Prunifolium.

USES AND DOSE.—Viburnum Opulus is an antispasmodic and a sedative ...

numerous rhombohedral crystals of calciu... fibers

SAMBUCUS

Sambucus or Elder Flowers (U. S. P. 1831 to 1905, N F. 1916 to 1947) is the air-dried flower of *Sambucus canadensis* Linné or of *Sambucus nigra* Linné *Sambucus* is from the Latin *sambuca*, meaning a stringed instrument made from elder-wood; *canadensis* refers to the habitat and *nigra* is Latin for black

The American Elder (*S. canadensis*) is a large shrub growing in rich moist soil throughout the eastern and central United States. The European Elder (*S nigra*) of Europe, weste... ... may attain a height of 30 feet. The plant has odd-... in flat cymes, and deep purp... sometimes used in making a wine The flowers are gathered in early summer during the dry and hot weather, carefully dried and preserved.

... is imported from Europe through Hamburg,

..., from 1 to 3 mm. in diameter; corolla, white when fresh, when dry weak yellowish orange to moderate yellow, urn-shaped and poss... ovary 3-l... spheroid... odor aromatic; ... omatic and bitter.

Sambucus co... a little tannin and a semisolid, yellowish volati... blossoms, which becomes more prominent as the oil is diluted. Total ash about 6.6 per cent; acid-insoluble ash 0.6 per cent.

Sambucus is used ... **...ver Water**, as a fragrant perfume and flavor. ... owers is used in collyria; the mucilage is not ... ug is a mild stimulant, carminative and diaphoretic. Average dose, 4 gm.

Sambuci Baccæ or Elder Berries (U S. P. 1820 to 1831) are the fruit of *Sambucus canadensis* Linné. The juice expressed from the berries *contains mucilage*, sugar and malic acid. It has long been used for making **Elder Berry Wine.** The freshly expressed, clarified juice, evaporated to a soft *extract, has been* recognized in European pharmacopœias as the base of a refrigerant, diuretic drink.

Elder Bark and Elder Leaves have been used as a purgative and diuretic, especially in dropsy.

Triosteum or Fever Root (U. S. P. 1820 to 1882) is the root of *Triosteum perfoliatum* Linné. The plant is a perennial herb up to 1.3 meters high, indigenous to rich woodlands in the United States. The rhizome is horizontal, up to 25 cm long and 2 cm. thick; the roots are numerous, up to 25 cm. long and yellowish brown in color. The fresh root is nauseous and bitter in taste, and in doses of 1 to 2 gm. is an active purgative and emetic.

VALERIANACEÆ, OR VALERIAN FAMILY

This is a family of 10 genera and about 350 species of herbs mostly indigenous to the northern hemisphere. The leaves are opposite; the flowers are usually small, the ovary being inferior, and the fruits are dry and indehiscent. The secretion cells have suberized walls and contain a volatile oil. In the rhizome and roots of *Valerian* the volatile oil is developed in the subepidermal layer. The walls of the tracheæ and wood fibers are marked by simple pores, except in the primary xylem where the tracheæ possess scalariform perforations. The non-glandular hairs are usually unicellular. The glandular hairs are small, having either a unicellular or a multicellular stalk and a multicellular summit. Calcium oxalate is wanting.

VALERIAN

Valerian (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the dried rhizome and roots of *Valeriana officinalis* Linné. Valerianus, emperor of Rome, A.D. 253 to 260, first used the plant in medicine, hence the plant name given in the ninth century A.D. The plant is a perennial

collected in autumn, cut into longitudinal slices and dried by artificial heat. There are several commercial varieties and it is said that some of the drug is derived from *Valeriana sylvatica*. Most of the commercial supply comes from Belgium and Holland. During medieval days valerian was used in cookery for its *delightful* flavor, and in the sixteenth century was accepted as a perfume, as it is employed in the Orient today.

DESCRIPTION.—Rhizome upright, slightly ellipsoidal, more or less truncate at both ends, from 2 to 4 cm. in length, and 1 to 2 cm. in diameter, usually

ellow-

sides

l with

numerous roots and few root-scars; fracture short, horny, internally light brown.

Roots 3 to 10 cm. in length, 0.5 to 1 mm. in diameter, longitudinally wrinkled and brittle.

STRUCTURE.—Root: epidermis of papillose cells, some being modified to root-hairs; subepidermal layer containing suberized secretion cells usually containing

parenchyma, a secondary thickening in the fibrovascular bundles and a periderm

of a few layers of cells. Sections of
parenchyma having scattered fibro
the endodermis, numerous more or
and a large pith.

POWDER.—Color weak brown to moderate yellowish brown; odor of valeric
cleft;
thicke
latter
with root-hairs and fragments of cork.

CONSTITUENTS.—A volatile oil, 0.5 to 2 per cent, composed of bornyl valerate
pinene,
a resin
nalates;
0.5 per
cent. The valerian odor is due to isovaleric acid, formed from bornyl acetate by an oxydase during the drying of the drug.

USES AND DOSE.—Valerian is used as an antispasmodic and a nervine. Average dose, 0.75 gm.

Oleum Valerianæ or Oil of Valerian (U. S. P. 1851 to 1894) is the volatile oil distilled from the rhizome and root of *Valeriana officinalis* Linné. The freshly gathered root is crushed or ground and distilled with water, the yield being larger from plants grown in dry soils. When recently prepared, the oil is yellowish or greenish, of a mild odor and a neutral reaction. On exposure to air it becomes brownish, of a strong odor and with an acid reaction. It is readily soluble in alcohol. Its constituents are given under Valerian. It is used as a sedative for hysteria. Dose, 0 05 to 0 1 cc.

Acidum Valerianicum or Valeric Acid (U. S. P. 1863 to 1882), $CH_3.CH_2.$
$CH_2.C$ ... in other plants, but is
less
usually
.tal-
liquid
line salts with alkalis.

Acid Ammonium Valerate (N. F. 1926 to date) is a nerve sedative, useful in nervous headache, insomnia, hysteria, neuralgia, etc.

ADULTERANTS AND SUBSTITUTES.—The most dangerous admixture that has been reported is veratrum, which is readily distinguished. *Cypripedium macranthum (Fam. Orchidaceæ), of Germany has been used as a substitute for valerian.*

ALLIED PLANTS.—**Kesso Root Oil** is obtained from **Japanese Valerian** (*Valeriana angustifolia*). The constituents are similar to those of the volatile oil in
alcohol. It has
valerian, but it cont
ican Valer-
an unpleasant flavor
er cent of
ian, *derived from V*
s English-
isovaleric acid. **India**
grown valerian and more agreeable to the taste

The small rhizomes of *Valeriana celtica*, a plant growing in the Styrian Alps, yield a volatile oil with an odor resembling that of anthemis and patchouly.

CUCURBITACEÆ, OR PUMPKIN FAMILY

This is a fa
of mostly tropical,
lly palmately
more or less
lobed; the stamens are more or less united either by their filaments or tortuous anthers, and the fruits are fleshy and indehiscent. *The fibro-*

vascular bundles are bicollateral and always separated by broad strands of parenchyma. In the herbaceous stems there is always a closed ring of sclerenchyma in the cortex and the fibrovascular bundles are arranged in 2 interrupted circles. In the fleshy perennial roots and shrub-like stems, showing a secondary growth, broad medullary rays are developed. Furthermore, there may also occur from 5 to 7 concentric rings of bundles, the sclerenchyma of the cortex being reduced to isolated groups of sclerenchymatous fibers The phloem is developed in other parts of the plant than in the fibrovascular bundles. The tracheæ are wide and the walls possess simple pores. The non-glandular hairs are unicellular or uniseriate and the cuticle is sometimes spinose, as the hairs on the leaves of *Bryonia*, *Cucumis*, *Cucurbita* and *Ecballium*. The glandular hairs have a short uniseriate stalk and a 4-celled summit. Cystoliths and cystolith-like structures are of common occurrence in a number of genera. Calcium oxalate is occasionally secreted in the form of solitary crystals.

COLOCYNTH

Colocynth, Colocynth Pulp or Bitter Apple (U. S. P. 1820 to 1936; N. F. 1936 to date) is the dried pulp of the unripe but full-grown fruit of *Citrullus Colocynthis* (Linné) Schrader.

Citrullus is the diminutive of *citrus* in allusion to the resemblance of the fruit to the orange, *Colocynthis* is from the Greek meaning a gourd or pumpkin. The plant is a perennial herbaceous vine, indigenous to warm, dry regions of Africa and Asia, and cultivated occasionally. The gathered fruit are peeled to remove the epicarp and quickly dried in the sun or artificially. Cultivated fruits are larger, but the drug from them is inferior. Commercial supplies are largely from Turkey, Spain and the Sudan, the finest grade being from Turkey. The seed are to be removed from the pulp before it is used.

Colocynth was well known to the Greeks and Romans and is mentioned by both Dioscorides and Pliny The drug was known to the Arabian physicians and was cultivated in Cyprus and Spain during the Middle Ages.

Description.—Berry nearly globular, 4 to 10 cm in diameter (Fig. 346); peeled, internally, with 3 longitudinal, somewhat elliptical fissures, 8 to 14 mm. in width, seed numerous, ovoid, compressed, light yellow to brown and borne on the parietal placentas, the pulp is light in weight, spongy, easily broken, light yellowish orange to pale yellow

Structure. See Figure 347

Powder Weak yellowish orange to yellowish gray, odor slight, taste intensely bitter, consisting chiefly of thin-walled, porous parenchyma cells, and rarely small *tracheæ accompanied by irregular, tubular laticiferous vessels*; very few or no lignified tissues, globules of fixed oil or aleurone tissues. The powdered drug with seed present contains numerous oil globules, aleurone grains and thick-walled, lignified stone cells (see Fig 347)

Constituents An amorphous glucoside in very small quantity, and an ether-chloroform-soluble resin probably represent the powerful activity of the drug, the inactive *a*-elaterin is present, but apparently none of the physiologically active *b*-elaterin, "colocynthin" and "colocynthitin" are indefinite

mixtures; "

oids are pre

alone yields, on an average, 9.9 per cent of natural ash, all of which is soluble in diluted hydrochloric acid.

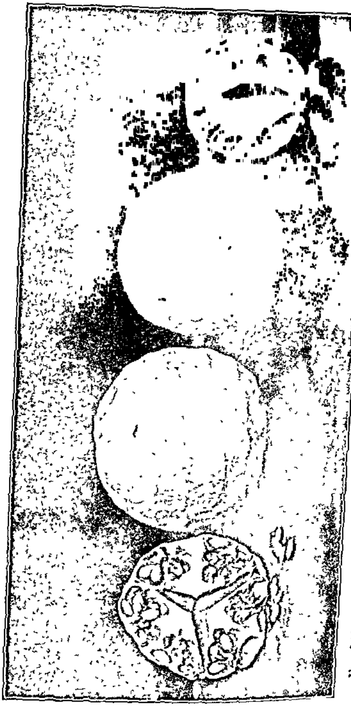


Fig. 318.—Colocynth fruits: Beginning at the left is seen a transverse section, fruit with epicarp removed, fruit with epıcarp present, and longitudinal section.

Standards and Tests.—Colocynth contains not more than 5 per cent of seed and not more than 2 per cent of epicarp and yields not more than 2 per cent of extractive with purified petroleum benzin and not more than 4 per cent of acid-insoluble ash.

Characteristic stone cells are few or absent in powdered colocynth (*epicarp and seed*). Aleurone grains and globules of fixed oil are few or absent (*seed*)

USES AND DOSE.—Colocynth is a drastic purgative or hydragogue cathartic. Average dose, 125 mg. "Colocynthin," 5 to 10 mg

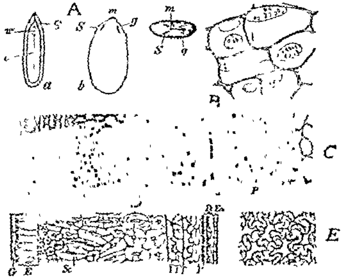


FIG. 347.—*Citrullus colocynthis* *A*, seed *a*, in longitudinal section, and *b* surface view; *S*, *deep clefts or fissures* *m* *micropyle*, *g*, *hilum*, *w*, *radicle*, *c*, *cotyledons* *B*, *Parenchyma* cells of ripe fruit showing simple pores, the walls are colored blue with zinc chloriodide *C*, Longitudinal section of wall of pericarp of ripe fruit showing *e*, epidermis, *p*, parenchyma, *Sc* sclerotic cells which gradually pass into a thick-walled parenchyma consisting of small cells (*p'*) *g* spiral vessels *P*, isodiametric porous parenchyma cells, containing air and of which the fruit for the most part consists *D* Cross-section of seed coat showing *G*, an outer layer which is more or less easily separable from the rest of the seed and the walls of which are somewhat mucilaginous, *E*, epidermis of palisade-like cells *Sc*, sclerotic cells, *Pl*, a layer of tabular cells with undulate walls *T*, a layer of small somewhat branching cells the walls of which are not strongly thickened and either porous or reticulate, *P*, several layers of parenchyma and the collapsed epidermis, *Pe* perisperm, *En* endosperm, *E* tangential section of tabular sclerotic cells of seed coat shown in *Pl* in Fig *D* (After Meyer)

BRYONIA

Bryonia or Bryony (U. S. P. 1882 to 1905, N. F. 1916 to date) is the dried root of *Bryonia alba* Linné or of *Bryonia dioica*, Jacquin

Bryonia, the Greek name, meaning to swell, alludes to the annual growth of the tuber, *dioica* means two households, alluding to the polygamous nature of the flowers, *alba*, Latin, means white, referring to the flowers The plants are perennial vines indigenous to central and southern Europe *B alba* produces black berries and *B dioica* red berries The root is gathered in the summer or fall, cut transversely into pieces and used either in the fresh or dried condition

DESCRIPTION In nearly circular disks, up to 10 cm in diameter and 15 mm thick, the edges are weak yellowish orange and very roughly wrinkled, the cut surface, nearly white or yellowish white, shows a cortex about 2 mm in width, a very broad radiate xylem, made up of concentric zones of bicollateral fibro-vascular bundles

POWDER.—Weak yellowish orange to weak yellow; odor faint but characteristic; taste bitter and nauseous; fragments of yellowish cork with thin-walled elongated cells; elongated, starch-bearing parenchyma cells of bark and medullary rays with cylindrical secretion cells containing a granular content, numerous simple or compound, rounded starch grains, up to 25 microns in diameter and usually with a central cleft; tracheal fragments with reticulate or simple pores.

CONSTITUENTS.—Bryonin, a yellow, amorphous, bitter, toxic, probably impure, strongly cathartic glucoside; Bryonidin, a colored, amorphous, bitter, toxic, readily soluble, probably impure glucoside which paralyzes the central nervous system; Bryonol, a phytosterol glucoside; Bryonicine, a white, amorphous alkaloid, insoluble in water, but forming soluble salts; a small amount of a volatile oil; a sugar; a mixture of fatty acids; and an enzyme which hydrolyzes bryonin to a resin and dextrose, and also effects the hydrolysis of amygdalin and salicin. Total ash, 5.45 per cent; acid-insoluble ash, 0.6 per cent.

USES AND DOSE.—Bryonia is a hydragogue cathartic. Average dose, 1 gm.

Elaterium (U. S. P. 1820 to 1882) is the dried precipitated residue from the fresh juice of the full-grown but unripe fruit of *Ecballium Elaterium* (Linné) A. Richard.

Elaterinum or Elaterin (U. S. P. 1882 to 1936) is a substance extracted from Elaterium.

The plant, known as Squirting Cucumber, is a decumbent, perennial herb indigenous to the Mediterranean region and cultivated in central Europe and England. The fruit is ovoid, fleshy, about 4 cm. in length, when unripe of a pale green color, and covered with numerous, uniseriate glandular hairs. When ripe, the fruit separates suddenly from the stalk, the juice with the seed being forcibly ejected f [illegible] the detached peduncle

To obtain the [illegible] ly pressed, then rinsed with [illegible] allowed to stand two hours, then decanted and re-precipitated. The precipitate is collected on filter paper, and pressed between warm, dry absorbent bricks until dry. Forty pounds of fresh fruit yields from 15 to 30 gm. of dry Elaterium

It usually occurs in rectangular pieces, from 3 to 4 cm. in length and about 5 mm. in thickness. When fresl [illegible] color, changing to a light grayish brown on keeping. [illegible] at aromatic odor and an acrid, bitter taste. [illegible] erin; 17 per cent of a resin; 6 per cent of starch.

Elaterin is a white, crystalline powder (very poisonous) of very bitter taste, [illegible] in hot alcohol about 1 to 100, it is extracted [illegible] ated then the

[illegible]

a-elaterin, up to 80 per cent, levorotatory and completely [illegible] action; some other inert material.

Both drugs are drastic purgatives. Average dose of elaterium, 10 to 30 mg.; of elaterin, 2 to 6 mg.

Pepo or Pumpkin Seed (U. S. P 1863 to 1936) is the dried, ripe seed of cultivated varieties of *Cucurbita Pepo* Linné, a procumbent herb native of tropical Ar [illegible] zones The seed are an [illegible] nd 2 to 3 mm. in [illegible] or somewhat rou [illegible] rallel to and [illegible] ter white and [illegible] mbryo white, straight, [illegible] slightly odorous when

[illegible] cells, the outer walls [illegible] eed were covered with [illegible] e cells; a subepidermal [illegible] ickened, lignified and

porous walls; a layer of strongly lignified stone cells, elliptical in outline, from 45 to 100 microns long, a single layer of small cells resembling those of the subepidermal layer; several rows of spongy parenchyma cells, with characteristic reticulate markings and separated from each other by large intercellular spaces, several layers of parenchyma cells, the inner layer being more or less collapsed and having on the inner portion a single epidermal layer, the cells having rather thick walls; the perisperm cells are usually more or less collapsed, the endosperm consists of a single layer of cells filled with small aleurone grains; the cotyledons consist of thin-walled, isodiametric, elongated, or palisade-like cells containing a fixed oil and numerous small aleurone grains.

Pepo contains fixed oil about 40 per cent; starch about 30 per cent; proteins; an acrid resin. Total ash about 4.55 per cent, mostly acid-soluble.

Pepo is an anthelmintic and a tænifuge. The seeds of other species of Cucurbita are also used in medicine, in Italy *C. maxima* (Winter Squash) and in the West Indies *C occidentalis* are the sources of the drug

The seed of Cucumber (*Cucumis sativus*), Muskmelon (*Cucumis melo*) and Lagenaria (*Cucurbita lagenaria*) are also occasionally used medicinally as is pumpkin seed. Watermelon seed (*Citrullus vulgaris*) contains a fixed oil and a resin, which consists in part of a crystalline compound, cucurbitol.

CAMPANULACEÆ, OR BLUEBELL FAMILY

This is a family of 61 genera and about 1500 species, which are widely distributed, those occurring in temperate regions being perennial herbs, while those of the tropics include shrubs and trees. The leaves are alternate; the flowers are regular and have either bell-shaped or somewhat bilabiate corollas; the fruits are either capsules or berries A very striking characteristic of the family is the occurrence of inulin in place of starch. Laticiferous tubes are abundantly developed in *Lobelia*, even occurring in the pith, the branches penetrating the tissues of the xylem and uniting with the tubes in the cortex. They are also found in other genera The leaf-teeth are usually terminated by glands, and in close proximity to them on the upper surface are large water pores. The non-glandular hairs are unicellular, being occasionally silicified. Calcium oxalate and glandular hairs are wanting

LOBELIA

Lobelia or Indian Tobacco (U S P, 1820 to 1936, N F 1936 to date) consists of the dried leaves and tops of *Lobelia inflata* Linné *Lobelia* was named in honor of Matthias de L'Obel, a Flemish botanist; (1538-1616), *inflata* is descriptive of the fruit, which is hollow and distended. The plant is an annual herb (Fig 348) indigenous to the eastern and central United States and Canada

Commercial supplies come from cultivated plants in Massachusetts, New York and Michigan It should be collected after a portion of the capsules have become inflated, and carefully dried and preserved Lobelia was employed by the Indians when necessity required, as a substitute for tobacco Its emetic properties were first observed by Cutter in 1785, and Thompson introduced it into medicine in 1807.

DESCRIPTION AND STRUCTURE - See Figure 348 and the National Formulary.

POWDER —*Color dusty yellow to weak greenish yellow, odor slightly irritating; taste strongly acrid, it contains conical non-glandular hairs up to 1 11 mm.*

in length; fragments of stem with tracheæ showing annular or spiral thickenings or simple pores associated with narrow wood fibers, the walls of the latter being rather thin, more or less lignified and porous; fragments of epidermis of leaf with elliptical stomata, up to 35 microns in length and usually with 3 or 4

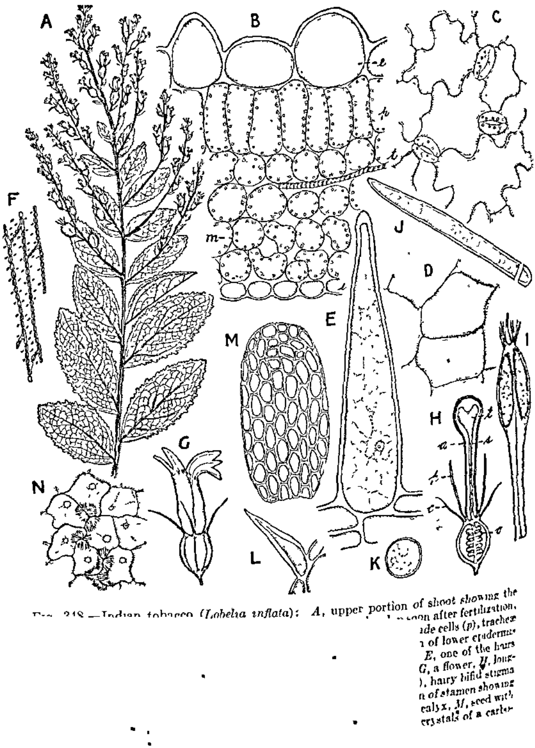


Fig. 318.—Indian tobacco (*Lobelia inflata*): *A*, upper portion of shoot showing the ... soon after fertilization. ... ide cells (*p*), tracheæ ... of lower epidermis ... *E*, one of the hairs ... *G*, a flower. *H*, long- ...), hairy bifid stigma ... n of stamen showing ... calyx. *M*, seed with ... crystals of a carbohydrate.

neighbor cells; pollen grains nearly spheroidal, 20 to 30 microns in diameter; seeds strongly reticulate, the seed coat composed of yellowish brown, polygonal cells having thick walls; fragments of branched laticiferous ducts having a granular content.

CONSTITUENTS.—The alkaloids lobeline, lobelanidine, and lobelanine, a non-acrid but pungent volatile oil; a colorless, tasteless, crystalline neutral principle, inflatin; *lobelic acid; waxy, fatty, resinous and gummy matters.*

Lobeline or *l*-Lobeline (to distinguish it from a mixture of the lobelia alkaloids also known as lobeline) occurs in colorless crystals very slightly soluble in water, but readily soluble in hot alcohol.

Lobeline Hydrochloride is *soluble in water, readily so in alcohol, and very* soluble in chloroform It is used as a prompt and powerful respiratory stimulant Dose. subcutaneously, 15 mg , intravenously, 5 to 10 mg

STANDARDS.—Lobelia contains not more than 10 per cent of its stems over 2 mm. in diameter and not more than 4 per cent of other foreign organic matter, and yields not more than 5 per cent of acid-insoluble ash

USES AND DOSE.—Lobelia is an expectorant and an emetic. Average dose, 0 1 gm.

Lobelia Seed are very small, brown, and resemble tobacco seed. They contain 30 per cent of fixed oil and lobeline. The oil, when pure, is bland, rapid-drying and resembles linseed oil

Commercial **Lobelia Oil** is obtained by extracting the herb with ether (which is then recovered) leaving a greenish, acrid oil containing the lobelia alkaloids

ADULTERANT.—*The seed of mullein (Verbascum thapsus) are commonly used* as an adulterant of lobelia seed, but are distinguished from them by not being reticulate

ALLIED PLANTS.—Red lobelia or cardinal flower, *Lobelia cardinalis*, and Blue lobelia, *L. syphilitica*, as well as *a large number of other species of Lobelia, are* used to some extent in medicine *Lobelia nicotianæfolia* of India and *Delissea acuminata* of the Hawaiian Islands have properties similar to *Lobelia inflata*

COMPOSITÆ, OR COMPOSITE FAMILY

This is the largest family of phanerogamous plants, comprising about 1000 genera and 23,000 species, which are very widely distributed. They are distinguished from all other plants in that the inflorescence is a head or capitulum, consisting of one or two kinds of flowers, arranged on a common torus and subtended by a number of bracts, forming an involucre. The flowers are epigynous and the fruit is an achene, usually surmounted by the persistent calyx, which consists of hairs, bristles, teeth or scales, which are known collectively as the pappus

The *individual flowers are called florets and may be hermaphrodite,* pistillate, monœcious, diœcious or neutral *Depending upon the shape* of the corolla, two kinds of flowers are recognized, one in which the corolla forms a tube, which is 5-lobed or 5-cleft, known as tubular flowers, and one in which the petals are united into a short tube, with an upper part that forms a large, strap-shaped, usually 5-toothed limb, known as ligulate flowers

In some of the plants of the *Compositæ* the head consists of ligulate flowers only, as in dandelion, chicory and lettuce, but in the larger number *of species the head is composed of both tubular and ligulate flowers or of tubular flowers alone When the head consists only of* tubular flowers it is called discoid, but when ligulate flowers are also present it is called radiate When the heads are radiate, as in the common daisy, the tubular flowers are spoken of as disk-flowers, and the ligulate flowers as ray-flowers The disk-flowers are usually perfect, while the ray-flowers are pistillate or neutral (without either stamens or

STANDARDS.—Arnica contains not more than 3 per cent of foreign organic matter. The involucre and torus of the flower-heads are frequently injured on the plant or after collection, by larvæ of the insect *Trypeta arnicivora;* the German pharmacopœia requires their removal from the drug, the florets alone being used.

USES AND DOSE.—Arnica used
increasing temperature and secre
followed by transient depression
bactericidal, irritant and even vesicant, the flowers proportionately stronger than the root. It is used mostly as a vulnerary for bruises, sprains, abrasions, slight wounds, etc. Average dose, 0.1 gm.

MATRICARIA

Matricaria, Hungarian Chamomile or German Chamomile (U. S. P. 1842 to 1926; N. F. 1926 to date) is the dried flower-head of *Matricaria chamomilla* Linné. *Matricaria* is from the Latin *matrix*, in allusion to the medicinal effect on that organ; *chamomilla* is a contraction of *chamæmelum*, Greek for earth-apple, in allusion to the apple-like odor of its flowers. The plant is an annual herb, indigenous to Europe and western Asia and naturalized in Australia and parts of the United States. The mature flower-heads are collected from wild plants. Matricaria has a large domestic use, especially among Germans.

and the National Formulary.
brown; odor pleas-
ierous, from *18 to*
the 3 pores, the

and strongly aromatic in odor and ta
air, the color gradually fades to gree.,
stem or involucre is present in the distilled drug.

STANDARDS.—Matricaria contains not more than 10 per cent of the stems of the plant and not more than 2 per cent of other foreign organic matter, and yields not more than 4 per cent of acid-insoluble ash.

USES AND DOSE.—Matricaria is a stimulant, a nervine, a carminative and a diaphoretic. Average dose, 15 gm.

ADULTERANTS.—In *Anthemis arvensis* the receptacle is solid and conical and the involucral scales are lanceolate. In *Anthemis cotula* the peduncles are slightly

Anther English Chamomile (U. S. P. 1820 to 1916), to south-
expandec *The*
ern and the
flowers a
principal supplies coming from Belgium, France and in diameter; the
The flower-heads are globular, compressed, 1.5 to 2 cm. involucre is hemispherical, with 2 or 3 rows of imbricated, nearly equal, some-

what elliptical, very pubescent ... iddle portion and a
yellowish ... 3 to 4 mm in height,
occasiona ... of an insect and with
chaff-scal ... scales, about 2 mm in length; the ligulate

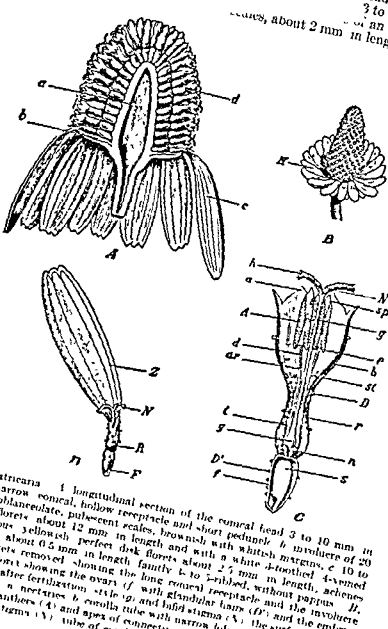


Fig. 150. Matricaria. *A*, longitudinal section of the conical head 3 to 10 mm in breadth: *a*, the narrow conical, hollow receptacle and short peduncle; *b*, involucre of 20 to 30 imbricate oblanceolate, pubescent scales, brownish with whitish margins; *c*, 10 to 20 pistillate ray florets about 12 mm in length and with a white 3-toothed, 4-veined corolla; *d*, numerous yellowish perfect disk florets about 2.5 mm in length; achenes somewhat obovoid about 0.5 mm in length, faintly 3- to 5-ribbed, without pappus. *B*, Head with the florets removed showing the long conical receptacle and the involucre (*H*). *C*, Tubular floret showing the ovary (*f*) with glandular hairs (*D'*) and the embryo (*S*) which develops after fertilization, style (*g*) and bifid stigma (*N*), the surface of which is covered with hairs; *n*, nectaries; *b*, corolla tube with narrow lobes (*a*); stamens showing filament (*st*), united anthers (*A*) and apex of connective (*sp*). *D*, Ligulate floret showing ovary (*F*) and bifid stigma (*N*), tube of corolla (*R*) and the upper ligulate portion (*Z*). (After Meyer.)

florets are numerous, 6 to 10 mm in length, with a white, 3-toothed, 4-nerved corolla, a glandular ovary about 1 mm in length, a slender style and bi-cleft stigma, the tubular florets are few or none, lemon-yellow, perfect, the achene oblong, without pappus, the odor distinct and the taste aromatic and bitter.

Microscopic mounts show
walled unicellular hairs and
occasional, spheroidal, abou
prickly; sclerenchymatous fi
thick walls; papillæ of corolla and stigma; small rosettes of calcium oxalate occasionally present; characteristic cells of anther.

Anthemis contains a volatile oil, which is bluish green when fresh, 0.8 to 1 per cent; a bitter crystalline glucoside, anthemisol; anthemic acid (see matricaria); 5.25 per cent of resin; 1.5 per cent of a bitter crystalline wax; and tannin. The volatile oil consists principally of the isobutyl, amyl and hexyl esters of butyric, angelic and tiglic acids, anthemol, an isomer of camphor, and azulene, hence dark blue in color.

Anthemis is a stimulant, a carminative, a nervine and a tonic. In large doses it is an emetic.

lig
en
pl

fr
of

in length, 1- to 3-toothed, 4- to 5-veined, margin nearly entire, tube enclosing the remains of a filiform style and bifid stigma, pubescent on the outer surface, ovary oblong, about 0.5 mm. in length, pubescent. The powder is bright yellow; odor distinct; taste faintly saline, slightly bitter; epidermal ... having sinuous walls, numerous oily globules and

oxalate in rosettes from 2 to 6 microns in diameter. ...
water the latter becomes a pale straw-color.

Calendula contains volatile oil; an amorphous bitter principle; a gummy substance, calendulin, which forms with water a transparent mucilage that is no ... Natural ash, 9.3 per cent, with 1.7 per cent of

a carminative. Average dose, 1 gm.

of various *Compositæ* are sometimes admixed with or substituted for calendula. Of these the following may be mentioned ... characteristics. The ligulate corolla tog
of ... la of *Arnica montana* is
7- ... is linear, about 13 mm.
in ... te, entire; and the ray ... t 20 mm. in length and
florets of *Tagetes patula* are somewhat ... with darker stripes, and have undulate
10 mm. in width, sometimes marked with darker stripes, and have undulate margins.

Cotula. Mayweed or Wild Chamomile (U. S. P. 1820 to 1882) is the dried ... to Europe, but now naturalized in America. The stem grows to be ... se upward, leaves sessile, ... The flower-heads terminate the branches; the receptacle is conical, solid, the ray florets white, 3-toothed, the disk florets yellow, with ribbed akenes and without pappus. The odor is fetid aromatic, the taste bitter and acrid.

Constituents.—A little volatile oil, resin, tannin, valeric and oxalic acids, an acrid fatty substance. The drug is more acrid than the English Chamomile; the juice of the fresh leaves will blister the skin. It has been used as a sudorific and antispasmodic, in colic and dysmenorrhea.

SANTONICA

Santonica or Levant Wormseed (U. S. P. 1863 to 1916) is the dried flower-heads of *Artemisia Cina* Berg.

Santonin (U. S. P. 1863 to 1942; N. F. 1942 to date) is the inner anhydride of santoninic acid ($C_{15}H_{15}O_{4}$) and obtained from santonica.

Artemisia was named for Queen Artemisia, wife of King Mausolus, who first employed it. The plant is a small shrub indigenous to the

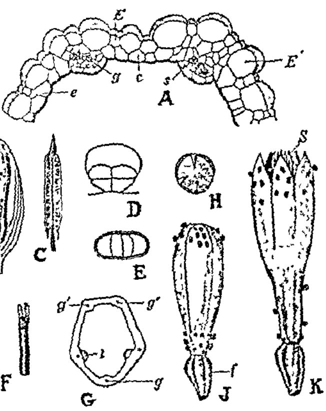


Fig. 351. Santonica. A, transverse section of the wall of the ovary: E, E', e, epidermal cells; g, tracheae; s, phloem. B, Longitudinal section through a flower-bud showing involucre (H). C, stamen. D, glandular hair of a bud-scale. E, glandular hair as viewed from above. F, style. G, transverse section of the wall of the ovary showing tracheae (g, g') and conducting cells traversed by pollen tube (t). H, pollen grain. J, flower-bud showing ovary (f). K, expanded flower showing stamens (S). (After Meyer.)

deserts of Russian Turkestan, from whence most of the commercial supply has come. It is now cultivated in western Washington state, and during World War II, the production of drug there has greatly increased. The flower-heads are collected in July and August before they expand, and are carefully dried and preserved. If the flower-heads are unexpanded and quickly dried they will yield over 3 per cent of santonin; just so soon as the flower matures, however, there is a rapid disappearance of the anthelmintic principle.

Santonica.—The flower-heads are oblong or ellipsoidal, 2 to 4 mm. in length, 1 to 1.5 mm. in diameter; t... imbricated, ovate or ovate-l... 2 mm. in length, with a yel... whitish margin; the rec... tubular flowers about 1... bracts; the ovary is ob... taste aromatic.

See Figure 351 for the structure.

The powder is light grayish brown, with nearly smooth spheroidal pollen grains from 15 to 20 microns in diameter, and having 3 pores; glandular hairs are of two kinds, either with 1 or 2 short cells or with 2 to 3 pairs of cells.

The drug contains santonin, 2 to 3.5 per cent; volatile oil about 2 per cent, consisting chiefly of cineol, some terpineol, terpinene and inactive pinene; a crystalline principle, artemisin, which is apparently oxysantonin; and a resin. ... becoming yellow on exposure to light; it ... soluble in alcohol; and is colored re...

Average dose of santonin, 60 mg. French Wormwood contains san-to...

A santonin-free santonica has been found in the markets of Europe and of this country.

The seed of *Quisqualis indica* (Fam. *Combretaceæ*) or Rangoon Creeper furnishes a substitute for santonica. The plant grows wild in the tropical regions of Asia, America and Africa. The best drug comes from the province of Szechwan, ... contains an active principle

GRINDELIA

Grindelia or Grindelia Robusta (U. S. P. 1882 to 1926; N. F. 1926 to date) consists of the dried leaves and flowering tops of *Grindelia camporum* Greene, of *Grindelia humilis* Hooker and Arnott, or of *Grindelia squarrosa* (Pursh) Dunal. Grindelia was named for D. H. Grindel, a Russian botanist, who died in 1836; *squarrosa* means scabby or scurfy, in reference to the appearance of the plant; *camporum* means a bell and refers to the shape of the flowers. The plants are perennial herbs of western North America. *Grindelia squarrosa* grows on the borders of California and Mexico extending northward to Canada; *Grindelia camporum*, the common gum plant of California, is found extensively in the western and central desert portions of California. Grindelia is collected in early summer, when the leaves and flowering tops are covered with a resinous exudation, and dried.

Grindelia was used by the California Indians and was known to the early Jesuit missionaries. In 1863 Canfield used it as a remedy for ivy poisoning, and in 1875 it was introduced into medicine.

Description and Structure.—See Figures 352 and 353 and the National Formulary.

Powder.—Light yellowish brown to yellow; odor balsamic; taste aromatic, ... elliptical stomata, ... the leaf ... lipsoidal.

ultlcellular head up to 100 microns in diameter, each cell of which contains a osette from 5 to 8 microns in diameter. Cells of mesophyll spheroidal, filled ith large chloroplasts, about 10 microns in diameter; large, somewhat elonated, thick-walled, colorless cells of water-storage tissue; pollen grains spheridal, about 35 microns in diameter, having 3 pores and a spinose cuticle; stem agments showing tracheæ having annual and spiral thickening and simple or ordered pores, associated with numerous narrow, strongly lignified wood fibers; ith cells more or less tabular and containing a layer of protoplasm in which re embedded numerous spheroidal granules

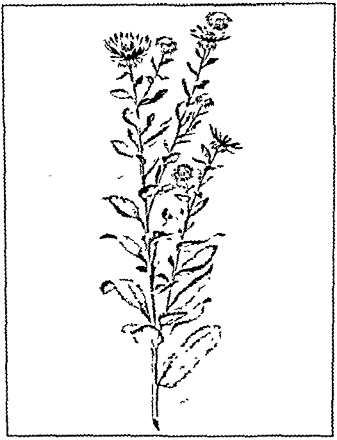


Fig. 452 Scaly Grindelia (*Grindelia squarrosa*) Flowering plant showing the oblong, sharply serrate, sessile leaves, and the heads, composed of numerous imbricated, squarrosely tipped or spreading scales the yellow ligulate ray florets directed upwards, and the central cone of numerous tubular florets (From Bulletin 219, Bureau of Plant Industry U S Department of Agriculture)

Constituents Resins about 21 per cent, a phytosterol glucoside, grindelol, a bitter crystalline alkaloid, grindeline, a levorotatory sugar, tannin 1.5 per cent, a *volatile oil having the characteristic odor of the drug*, about 8 per cent of ash

Standards. Grindelia contains not more than 10 per cent of its stems over 2 *mm. in diameter*

Uses and Dose Grindelia is used as a sedative, an antispasmodic and an expectorant The fluidextract is used in the treatment of poisoning by *Rhus toxicodendron* Average dose, 2 gm.

Allied Plants.—Other species of *Grindelia* growing in the western United States and *Mexico* are similarly employed ...

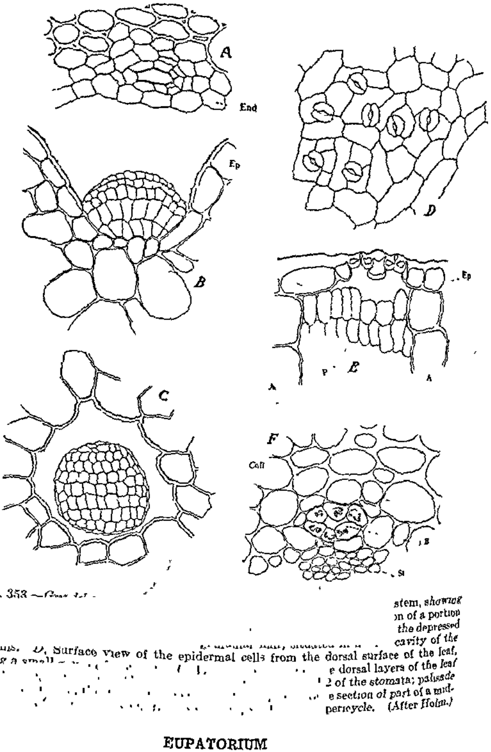


Fig. 353.— ... stem, showing ... on of a portion ... the depressed ... cavity of the epidermis. *D*, Surface view of the epidermal cells from the dorsal surface of the leaf, showing a small ... e dorsal layers of the leaf show ... 2 of the stomata; palisade cells (... e section of part of a mid-rib of ... pericycle. (After Holm.)

EUPATORIUM

Eupatorium, Thoroughwort or Boneset (U. S. P. 1820 to 1916; N. F. 1926 to date) consists of the dried leaves and flowering tops of *Eupatorium perfoliatum* Linné. *Eupatorium* was named in honor of Eupator,

King of Pontus, who is said to have used one of the species in medicine; *perfoliatum* means having a sessile, clasping leaf.

The plant is a perennial herb (Fig. 354) indigenous to eastern and central North America. The drug was used as a domestic remedy by the early colonists. It was a favorite remedy in the practice of American medicine at least a hundred years before there was a print in an American materia medica.

FIG. 354 1 *Eupatorium perfoliatum* with opposite connate-perfoliate leaves and cymose-paniculate inflorescence. 2 *Eupatorium purpureum* with verticillate, petiolate leaves and a large terminal panicle of flowers.

DESCRIPTION. Usually in more or less broken fragments. Leaves lanceolate, opposite, 10 to 20 cm in length, 2 to 5 cm in breadth, apex acuminate; base connate-perfoliate, margin crenate-serrate, upper surface light olive to dark yellowish green, rugose and mostly glabrous, under surface paler, tomentose, and dotted with minute glistening, yellow resin masses. Flower-heads are small, numerous and corymbed, receptacle flat, involucre light green, oblong, the scales imbricate, linear-lanceolate, hairy, corolla 5-toothed, whitish, anthers purplish, included, style deeply cleft, much exserted. Achenes 5-angled, pappus consisting of a single row of about 20 rough bristles.

POWDER. Weak yellow to light olive, odor faintly aromatic, taste strongly bitter. Non-glandular hairs 2- to 5-celled, finely striate, thin-walled, the end cells pointed or somewhat rounded, glandular hairs short-stalked and with

multicellular heads up to 80 microns in diameter; pollen grains ellipsoidal, up to 25 microns in diameter, and with numerous [illegible]

[illegible] pericarp with cells having characteristically thickened, brown to yellow walls; occasional fragments of stem tissues; and of corolla tissues.

CONSTITUENTS [illegible] a crystalline wa[illegible] lizing in small [illegible] acetate solution, a glucosidal tannin, which is colored deep green with ferric chloride and gives a yellow precipitate with lead acetate solution; gallic acid; total ash, 7.5 to 9.9 *per cent.*

STANDARDS.—Eupatorium contains not more than 10 per cent of its stems.

USES AND DOSE.—Eupatorium is used as a stimulant and diaphoretic; in large doses it is also an emetic and a cathartic. Average dose, 2 gm.

Eupatorium Teucrifolium or Wild Horehound (U. S. P. 1820 to 1842) consists of the leaves and flowering tops of *Eupatorium teucrifolium* Willdenow. The leaves are al[illegible] runcate, and serrate toward the base [illegible] to Louisiana. The drug resembles t[illegible]

Eupatorium Purpureum, Joe-pye Weed or Gravel-root (U. S. P. 1820 to 1842) consists of the rhizome and roots of *Eupatorium purpureum* Linné. The plant is common (see Fig. 354) in low grounds in eastern and central North America, and is a tall stout herb, with oblong-lanceolate leaves, 3 to 6 in a whorl, and light purplish red flowers in dense corymbs. Purple boneset contains a volatile oil, 0.07 per cent; a yellow crystalline principle, euparin, which somewhat resembles quercitrin; resin, 0.25 per cent; calcium oxalate, 1.82 per cent; and ash, 14 per cent.

Dog-fennel (*Eupatorium capillifolium* [Lam.] Small, or *E. fœniculaceum* Willd.), a perennial herb, with alternate, 1- to 2-pinnately parted leaves and white flowers, which is common in the Southern States, and yields a volatile oil which contains considerable phellandrene. The juice of the herb is used for relieving pain from the bites of insects.

TARAXACUM

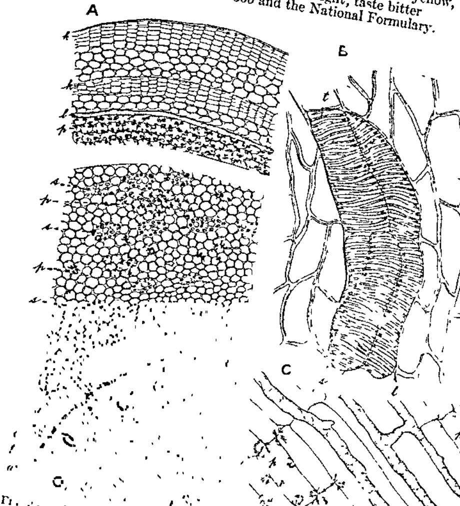
Taraxacum or Dandelion Root (U. S. P. 1831 to 1926; N. F. 1926 to date) consists of the dried rhizome and roots of *Taraxacum officinale* Weber or *Taraxacum lævigatum* DeCandolle. *Taraxacum* probably is from the Greek *taraxis* meaning inflammation of the eye, for which the juice is used; *lævigatum* is Latin meaning smooth or to make smooth. The drug is mentioned in the writings of Hippocrates, Galen, Paulus and Avicenna (980–1037), and other physicians down to the present day. The plant is a perennial herb indigenous to Europe and Asia, but now naturalized in all civilized parts of the world.

The drug should be collected either directly before or after the vegetative activity of the plant. It is used in either the fresh or dry condition, and should be protected against the development of insects.

DESCRIPTION.—Somewhat cylindrical, tapering, flattened and branched, 6 to 15 cm. in length, and often broken into irregular pieces; externally moderate yellowish brown to brownish black, wrinkled with numerous rootlet scars; crown simple or branched, slightly annulate from numerous leaf bases; fracture

short, horny when dry, tough when damp; internally bark light brown, 2 to 6 mm. in thickness, made up of concentric layers of laticiferous vessels and sieve alternating with white parenchyma; wood lemon-yellow, 1 to 4 mm. in thickness, porous and non-radiate, odor slight; taste bitter

STRUCTURE.—See Figure 355 and the National Formulary.



Fi[illegible] [illegible]axacum A, transverse section of root showing cork (k), parenchyma containing inulin (p), laticiferous vessels (l), phloem groups (s) composed of sieve and laticiferous vessels, cambium (c), tracheæ (t), modified, non-lignified wood fibers (Ersatzfasern) (u) B, Longitudinal section of xylem showing several of the reticulate tracheæ and the modified wood fibers with oblique pores that are apparent in preparations made with zinc chloriodide C Longitudinal section of a phloem group showing branching laticiferous vessels (l), sieve cells (s), and parenchyma (p) containing sphero-crystals of inulin

POWDER - Pale brown to weak yellowish orange, odorless, taste bitter; parenchyma cells large, thin-walled and with irregular, glistening masses of inulin, fragments with brown to yellow, anastomosing laticiferous vessels, spiral and reticulate tracheæ and non-lignified wood fibers, with simple, irregular or oblique pores, starch is absent

CONSTITUENTS.—A bitter, amorphous, dark-colored substance, inulin about 25 per cent; a volatile oil, an enzyme, levulose, choline; para-hydroxyphenyl-

acetic acid; 3:4-dihydroxycinnamic acid; a mixture of fatty acids; two monohydric alcohols, taraxasterol and homotaraxasterol; and a substance which has been designated "cluytianol" (see *Cluytia similis*), but which apparently is a phytosterol glucoside

STANDARDS.—Taraxacum contains not more than 2 per cent of foreign organic matter, and yields not more than 4 per cent of acid-insoluble ash.

USES AND DOSE.—Taraxacum is a diuretic, a tonic and an aperient. Average dose, 4 gm.

Chicory, Succory or Blue Dandelion Root is the rhizome and roots of *Cichorium int* to Europe and localized throughout the no The root, is upright, fusiform and deep-seated. early spring or the fall, from younger plan preserved against moisture and insect attacks.

Chicory somewhat resembles taraxacum, but the outer surface is light or dark brown, and irregularly, often spirally wrinkled; the inner surface shows a thick bark, having radiating strands of phloem; a yellowish wood having narrow radiating medullary rays and xylem wedges with broad tracheæ.

The powder shows free masses of inulin, which, in roasted chicory, are dark brown, soft, sweetis tion; irregular mass up to 10 microns in ends, from 100 to pores.

Chicory is sometimes adulterated with the roots of dandelion, carrot, beet and turnip, as well as cereal proc and a diuretic. When roasted, *it is used as a substitute for or*

Inula or Elecampane (U. S. I 36) is the dried herb indigenous Carolina. r plants, ttacks. omewhat tudinally annulate and surmounted by a stem-scar, the lower portion wrinkled; usually in irregular pieces; externally light to dark brown, longitudinally wrinkled with short roots or circular root-scars and occasionally having the cork more or less abraded, showing a grayish white cortex; fracture tough, horny and somewhat uneven; internally light brown, showing a distinct cambium and numerous large resin canals in both the xylem and cortex; odor distinct, aromatic; acid and pungent.

Older rhizome occurs should be rejected. The ro er rhizomes, but *without a pith; the primary tracheæ are associated with elongated, thin-walled cells with reticulate perforations.*

Inula contains inulin, 35 to 45 per cent; alantol, 1 to 2 per cent, consisting chiefly of helenin, with small quantities of alantolic acid, camphor and isohelenin; a bitter principle; inulenin, pseudoinulin and mucilage. Total ash 4.4 per cent; acid-insoluble ash 0 3 per cent. **Alantol** is obtained by distillation with wa steam, and is an oily substance with the odor and taste of peppermint. alantolactone in white crystal soluble in most o sed as antiseptics and expectorants in throat and bronchial of helenin, 10 to 20 mg.; maximum dose daily 100 mg. **Phytomelane** (see Fig. 357), a brown or nearly black, carbon-like substance occurs occasionally in the intercellular spaces between the parenchyma cells.

The powder is very light brown; on boiling with water it emits a distinct aromatic, pepper-like odor, distinguishing it from *belladonna*; it shows inulin in the parenchyma cells, mostly in the form of separate, irregular, colorless

granules, up to 30 mic[illegible]
brown resin masses f
tracheæ having narrc
bordered pores, very
simple pores; fragme
having relatively thin brownish walls, the cells usually containing a granular

(see Belladonnæ Radix).

Inula is an aromatic stimulant, it is used also as an expectorant, a diaphoretic and a diuretic

Inulin or Hydrous Inulin (N. F. 1936 to date, as reagent) is a fructosan $(C_6H_{10}O_5)_n{:}XH_2O$, obtained from the subterranean organs of members of the family *Compositæ*. It is especially abundant in Taraxacum, Inula, Lappa and Pyrethrum rhizome and roots. Inula occurs in the cell sap; by immersing the fresh rhizome or root in alcohol for some time the inulin usually crystallizes in sphærite aggregates. Upon drying the plant part it forms refractive masses, more or less filling the parenchyma cells. It is readily soluble in hot water, slightly so in cold water or in alcohol. Its aqueous solution is levorotatory and neutral to litmus paper. Inulin is used in culture media as a fermentative identifying agent for certain bacteria, and in laboratory methods for the evaluation of renal function.

Lappa or Burdock Root (U S P 1831 to 1842, 1851 to 1916, N. F. 1916 to 1947) is the dried first-year root of *Arctium Lappa* Linné or of *Arctium minus* Bernhardi. *Arctium*, Greek, means a bear and a plant, in reference to the persistent burrs, *Lappa* is Latin for burr, and *minus*, Latin, refers to the smaller species

The plants are biennial herbs indigenous to Europe and northern Asia and naturalized in waste places in the United States and Canada The fleshy root is collected in autumn from plants of the first year's growth and carefully dried Most of the commercial supplies come from Belgium, France and Germany.

[illegible] igi-
[illegible] to
[illegible] tlet

weak yellow, radiate, bark 2 to 3 mm in thickness, wood porous, cambium zone distinct, odor slight, taste mucilaginous, slightly bitter

Old woody roots in which the center is more or less obliterated and which ha[illegible]

of [illegible]
cambium distinct, xylem composed of narrow wedges, made up mostly of parenchyma, and a fe[illegible]
broad medullary rays
in the form of highly
in length, tracheæ from 50 to 150 microns in width, and marked by numerous narrow, simple pores and occasionally accompanied by narrow thin-walled wood fibers. Tissues of the pericycle and primary cortex are commonly seen in

the outer layers of the bark. The outer cortical region shows an *interrupted* circle of resin canals, which are wanting in older roots.

Lappa contains inulin, about 45 per cent; about 0.07 per cent of a volatile oil; a bitter principle; about 0.04 per cent of a fixed oil; resin; tannic acid; mucilage; and a sugar. Total ash, 4 per cent; acid-insoluble ash, 0.15 per cent.

Lappa contains not more than 4 per cent of attached leaf bases, and yields not more than 3 per cent of acid-insoluble ash, not less than 8 per cent of alcohol- [illegible] de fiber. A good quality [illegible] extractive.

Average dose, 2 gm.

[illegible] k Fruit (Seed) (U. S. P.

The fruits (seed) are about [illegible] deprived of pappus hairs; gray- [illegible] bitter in taste. The fruits con [illegible] about 1 per cent; a light yellow fixed oil, about 15 per cent. Average dose of the 10 per cent tincture, 10 cc.

ECHINACEA

Echinacea or Cone Flower (N. F. 1916 to date) consists of the dried rhizome and roots of *Echinacea pallida* (Nuttall) Britton or of *Echinacea angustifolia* (DeCandolle) Heller. *Echinacea* is from the Greek *echinos* meaning hedgehog, in reference to the rough-bristly leaves and stems of some species; *angustifolia*, Latin, means narrow-leaf, *pallida*, Latin, means pale. The plants are perennial herbs, *E. angustifolia* being the purple cone-flower of the southwestern United States, and *E. pallida* occurring throughout the central United States and extensively cultivated as cone-flower. The rhizomes and roots are collected from well-developed plants in the autumn and carefully dried (Fig. 356). Most of the commercial supply comes from Kansas.

DESCRIPTION [illegible] tapering; 10 to 20 cm in length, 4 to [illegible] moderate yellowish brown, lightly [illegible] nal V-shaped stem- [illegible] occasionally spirally [illegible] mm. in thickness, [illegible] wedges; a circular [illegible] owed by an acrid and tingling sensation resembling that of aconite, but lacking the persistency and numbing qualities of the latter.

STRUCTURE.—See Figure 357 and the National Formulary.

[illegible] 7 per cent, [illegible] ing of two [illegible] ic, linolic, [illegible] Total ash, [illegible]

STANDARDS.—Echinacea contains not more than [illegible] gn organic matter, and yields not more than 2 per cent of acid-insoluble ash. Echinacea which has lost its characteristic odor and taste must not be used.

USES AND DOSE.—Echinacea is a diaphoretic and an alterative. Average dose, 1 gm.

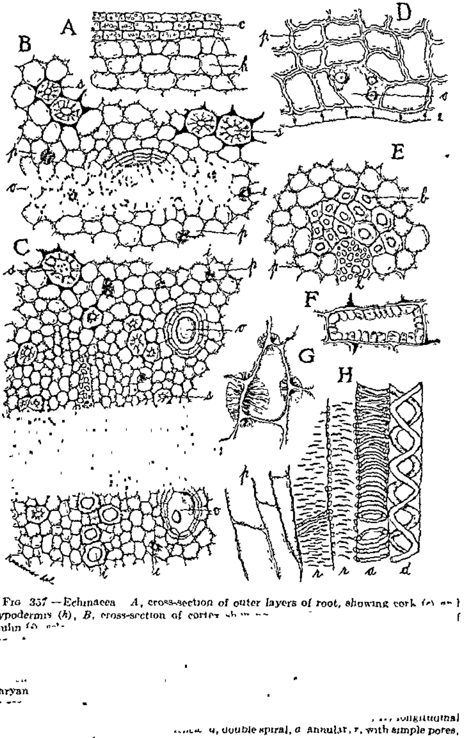


FIG 357 — Echinacea *A*, cross-section of outer layers of root, showing cork (c) and hypodermis (*h*), *B*, cross-section of cortex ... inulin (*i*) ...

paryan

... longitudinal ... d, double spiral, *a* annular, *r*, with simple pores, *p*, adjoining parenchyma

FIG. 356.—An entire plant of *Echinacea angustifolia* showing the lanceolate 3-nerved leaves and the conical heads with reflexed, ligulate ray florets. (From Year Book, U. S. Department of Agriculture.)

PYRETHRUM

Pyrethrum, Pyrethri Flores or Insect Flowers (N. F. 1947 to date) is the dried flower-head of *Chrysanthemum cinerariæfolium* (Treviranus) Bocc., *Chrysanthemum coccineum* Willdenow (*C. roseum* Weber and Mohr) or of *Chrysanthemum Marschalli* Aschers. Pyrethrum yields not less than 0.5 per cent of total pyrethrins (Pyrethrin I and Pyrethrin II).

Chrysanthemum is the ancient Greek name meaning golden flower; *cinerariæfolium* is from two Greek words meaning ash-colored leaves; *roseum* means rose-colored. Dalmatian insect powder is obtained from *C. cinerariæfolium*, a perennial herb indigenous to Dalmatia and Herze-

govina, where it is also cultivated as well as in Africa, New York, and California and to a large extent in Japan. The Persian insect powder is derived from *C. roseum* and *C. Marschallii*, perennial herbs growing in the Caucasus regions, Armenia and northern Persia. The flowers are collected from two- to six-year-old plants, the flower heads being torn off by a combing machine and carefully dried and preserved. The finest and most powerful insect powder is obtained from the closed or only partly expanded flowers, provided they are properly dried and preserved.

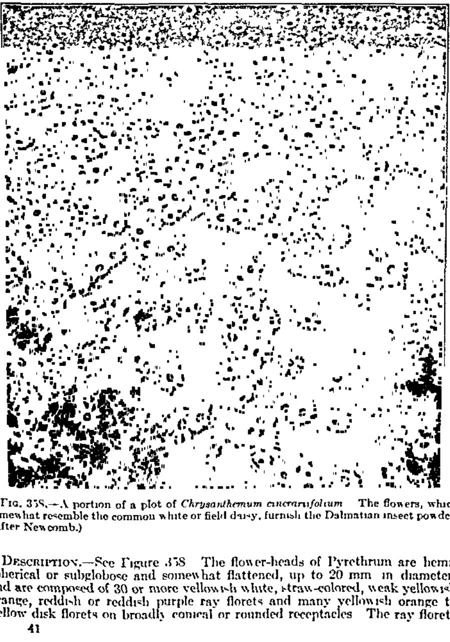


Fig. 358.—A portion of a plot of *Chrysanthemum cinerariifolium*. The flowers, which somewhat resemble the common white or field daisy, furnish the Dalmatian insect powder. (After Newcomb.)

Description.—See Figure 358. The flower-heads of Pyrethrum are hemispherical or subglobose and somewhat flattened, up to 20 mm in diameter, and are composed of 30 or more yellowish white, straw-colored, weak yellowish orange, reddish or reddish purple ray florets and many yellowish orange to yellow disk florets on broadly conical or rounded receptacles. The ray florets

are pistillate, 1 to 2 cm. in length and terminating in tl The disk florets are up to 7 mm. in leng achenes, the latter or pappus. The in bracts, the outer bracts being lanceolate and distinctly keeled, somewhat hairy on the outer surface

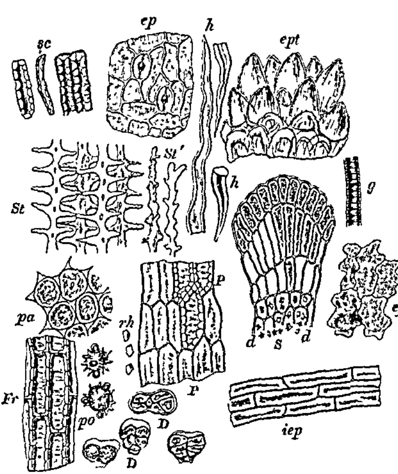


FIG. 359.—Pyrethrum (Insect flowers): *sc*, stone cells, *ep*, upper epidermis of a bract,

of calcium oxalate, *ep'*, epidermis of the under surface of a ligulate corolla, *P*, section of pappus s shown at pericarp *iep*, cells

and smooth, shiny and w The inner bracts are spatulate, long reddish brown membrano are cylindrical, grayish or ribs.

POWDER.—See Figure 359 and the National Formulary.

toxic to insects are Pyrethrin I ing esters of the alcohol Pyreth- atile oil.

ye daisy (*Chrysanthemum leucanthemum*), which can be detected microscopically by the nearly black secretion

sacs, the irregular dark red fragments of the achene and the palisade cells comprising the costal tissue of the achene. It is stated that sometimes the entire stem with leaves is ground up with the flowers. Powdered insect flowers, which are bright yellow in color, usually have added to them powdered curcuma or chromate of lead.

USES.—Powdered insect flowers is used as an insecticide. The most effective powder is said to be one 80 per cent of which will pass a 280 standard mesh sieve. Such powders are prepared by means of air-separation during the process of milling. Liquid preparations containing the toxic principles of insect flowers, kerosene and methylsalicylate, are being extensively employed in the form of sprays as fly and insect repellants.

Pyrethrum or Pellitory (U. S. P. 1820 to 1926) is the dried root of *Anacyclus pyrethrum*, a perennial herb indigenous to northern Africa and southern Europe, the commercial article coming from Algeria. The root is collected in autumn and dried.

The root is nearly cylindrical, slightly tapering, or broken into irregular pieces, 2.5 to 10 cm. in length, 3 to 20 mm. in diameter, externally dark brown, wrinkled and somewhat furrowed longitudinally, with few rootlets or rootlet scars; the crown is somewhat annulate from scars of bud-scales and sometimes tufted with coarse fibers of fibrovascular tissue or having long, soft-woolly, nearly straight, 1-celled hairs; the fracture is short and horny when dry, tough when damp; internally the bark is dark brown, with 2 circular rows of resin canals, 0.5 to 1 mm. in thickness and closely adhering to the light yellow, radiate, porous wood, in the medullary rays of which resin canals are also found, the odor is distinct and penetrating and the taste pungent, and acrid.

The powder is light to dark brown, and shows parenchymatous cells with irregular crystalloidal masses of inulin, nearly isodiametric stone cells, the contents of which are yellowish brown, reticulate, narrow, tracheæ, a few sclerenchymatous fibers, the resin canals containing yellowish brown amorphous masses of a volatile oil and resin.

Pyrethrum contains an alkaloid, pyrethrine, which occurs in colorless, acicular crystals, has an intense pungent taste and is decomposed by alkalis into piperidine (a pungent principle occurring in black pepper) and pyrethric acid, a principle resembling piperic acid. Pyrethrum also contains a brown, acrid resin, two other acrid resins, a volatile oil and about 50 per cent of inulin.

Pyrethrum is a stimulant, a sialagogue, an irritant and a rubefacient.

German Pellitory, the root of *Anacyclus officinarum*, is smaller than pyrethrum, the bark contains but one row of secretion reservoirs, which are wanting in the medullary rays; and the roots contain tannin in addition to the constituents found in pyrethrum.

Absinthium, Common Wormwood or Absinthe (U. S. P. 1831 to 1905, N. F. 1916 to 1926) consists of the dried leaves and flowering tops of *Artemisia absinthium*, a shrubby perennial herb, growing in waste places in the northern United States and Canada. It is cultivated in Europe, northern Africa, New York, Michigan, Nebraska and Wisconsin. The volatile oil is used in the preparation of the French Absinthe. The leaves and flowering tops are gathered during the summer or early fall, carefully dried and preserved.

The leaves are from 5 to 12 cm. in length, 2- to 3-pinnately divided, the lobes being obovate or lanceolate, entire or toothed, the lower being long petiolate, the heads are greenish yellow, hemispherical or ovoid and arranged in panicles, the involucral scales being in two series, the inner linear and having membranous margins, the florets are all tubular, the outer ones sometimes being neutral. The herb is aromatic and very bitter.

Non-glandular hairs of two kinds are present. (*a*) Unicellular, very long. (*b*) T-hairs consisting of a 1- to 4-celled stalk, bearing a single horizontal cell at the summit; glandular hairs having a 1- or 2-celled stalk and a glandular summit consisting of 4 to 8 cells; the pollen grains are spheroidal, about 30 microns in diameter, nearly smooth, and having 3 pores, calcium oxalate is in

rosette aggregates about 10 microns in diameter; the tracheæ are spiral or have

the plant, and consists of *d*-thumone (absinthol), thujyl alcohol, free and combined with acetic, isovaleric and palmitic acids, phellandrene and cadinene; also

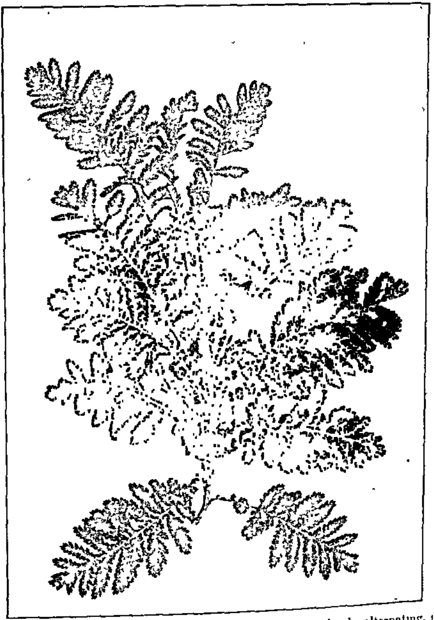


FIG 360 —Branch of Tansy (*Tanacetum vulgare*) showing closely alternating, deeply pinnatifid or pinnately divided leaves, the divisions being linear, oblong and variously lobed and incised.

a bitter glucosidal principle, absinthin, which forms white prisms and yields on hydrolysis a volatile oil, a resin, starch; tannin; succinic acid; potassium succinate and about 10 per cent of natural ash with about 1.3 per cent of acid-insoluble ash.

Absinthium is used as a tonic, a stimulant, an anthelmintic and a febrifuge. Average dose, 2 gm.

Achillea, Yarrow or Milfoil (U. S P. 1863 to 1882) consists of the dried leaves and flowering tops of *Achillea millefolium*, a common roadside weed, naturalized from Europe and Asia, and contains about 0.1 per cent of a dark blue volatile oil with a strongly aromatic odor and a small amount of a bitter alkaloid, achilleine. *The roots of yarrow, on the other hand, yield a volatile oil with a* valerian-like odor.

Achillea is used as a tonic, a stimulant and an emmenagogue.

Achillea nobilis of Europe contains an oil resembling that of yarrow, but is of finer quality and has a spice-like taste. *Achillea moschata*, an alpine plant of Europe, *yields three alkaloids and a volatile oil containing cineol and is used* in Italy in the preparation of the liquor, "Esprit d'Iva" *Achillea tanacetifolia* yields a blue volatile oil having the odor of tansy.

Tanacetum or Tansy (U. S P 1820 to 1905) consists of the dried leaves and flowering tops of *Tanacetum vulgare*, a perennial aromatic herb (Fig 360), *indigenous to Europe, extensively cultivated and naturalized in the United* States. The leaves are large and pinnately divided, and the flowers, both tubular and ligulate, are yellow, the heads being in terminal corymbs.

The powder is yellowish green and shows a few 4- to 5-celled [illegible] r hairs, about 150 microns in length, the ind[illegible] g *and with yellowish brown* [illegible] and large [illegible] cells [illegible] having nume[illegible] grains with numerous spino[illegible] tracheæ having scalariform and reticulate p[illegible] bordered *pores, thin-walled sclerenchymatous fibers free* from pores

Tansy yields from 0 1 to 0 3 per cent of a volatile oil, consisting of thujone, borneol and camphor, and also three resins

Tansy is used as a stimulant, an emmenagogue and an anthelmintic.

ERIGERON

Erigeron Heterophyllum, *Daisy Fleabane or Sweet Scabious* (*U. S P 1831* to 1863, as Erigeron, 1863 to 1882) consists of the leaves and tops of *Erigeron heterophyllum* Muhlenberg

Erigeron Philadelphicum or Philadelphia Fleabane (U S P 1831 to 1863, as Erigeron, 1863 to 1882) consists of the leaves and tops of *Erigeron philadelphicus* Linné

Erigeron or Fleabane (U S P 1863 to 1882), see Erigeron Heterophyllum and Erigeron Philadelphicum

Erigeron Canadense or Canada Fleabane (U S P 1820 to 1882) consists of the leaves and flowering tops of *Erigeron canadense* Linné

Oleum Erigerontis, Oil of Erigeron, Oil of Canada Erigeron or Oil of Fleabane (U S P 1863 to 1916) is the volatile oil distilled from the fresh flowering herb of *Erigeron canadense* Linné

Erigeron, from the Greek, means spring and old man, and refers to the hoariness of some species in the early spring The plants are annual or biennial (*E philadelphicus* perennial), and are common weeds in many parts of the United States and Canada east of the Mississippi River They prefer moist, good soil The leaves are alternate or basal and, with the stems, usually are hairy. The flower-heads *are relatively small and, especially on E canadense,* are numerous Odor is aromatic and taste is bitterish, acrid and somewhat astringent, *E canadense* being the strongest

The plants contain volatile oil, that from *E canadense* much more abundant, some resin, a little tannin, mucilage, etc , neither glucosides nor alkaloids have been noted

The drugs are stimulant and diuretic, the volatile oil is much the strongest, having been used to quicken uterine contractions Dose of the herbs, 2 gm., *of the oil, 0 3 cc*

Farfara, Tussilago or Coltsfoot (N. F. 1916 to 1936) is the dried leaf of *Tussilago farfara*, a low perennial or acaulescent herb, indigenous to Europe and growing in wet places and along roadsides in the northern United States and Canada. The variegated variety, the leaves of which have a creamy white margin, is a common ornamental plant, thriving in shady places. The leaves are gathered in June and July, after the flowering of the plant, carefully dried and preserved.

The leaves usually occur in broken pieces; when whole they are ovate-reniform, long petiolate, from 8 to 15 c[illegible] angulate lobes, and dentate m[illegible] *and glabrous ventral surface;* [illegible] prominent palmate veins; the [illegible] slightly bitter.

The powder is yellowish green and shows numerous multicellular, non-branching hairs, usually curved and twisted together, the terminal cells much elongated, and sometimes with spiral bands; broadly elliptical stomata up to 54 microns in length and associated with finely striated epidermal cells with wavy vertical walls; beneath each stoma is a 6-sided characteristic intercellular space; few non-porous fibers with walls from 6 to 12 microns in thickness.

Coltsfoot contains an acrid volatile oil, a bitter glucoside, gallic acid, albuminous substances, a caoutchouc-like substance, resin and tannin. Well-cleaned leaves yield about 10 per cent of total ash and about 0.25 per cent of acid-insoluble ash; commercial drug from 1.5 to 3.5 per cent of acid-insoluble ash The drug yields from 14 to 16 per cent of non-volatile extractive when exhausted with diluted alcohol Moldy or decomposed leaves from partially dried drugs causes inferiority. Old, dead leaves are sometimes present, and occasionally an excess of sand.

Coltsfoot is a demulcent. It is also used as an expectorant.

Senecio, Golden Senecio, Ragwort or Life Root (N. F. 1916 to 1936) is the dri[illegible] swamps an[illegible] carefully dried.

The drug consists of a group of basal leaves and a leafy, flowering scape. The basal leaves are orbicular or oblong, long petiolate, the lamina from 1 to 6 cm. in length and 1 to 5 cm. in brea[illegible] acute or cordate base, a crenate-dentate margin; [illegible] considerably wrinkled, glabrous, [illegible] *prominent; the petioles are from 3 to 8 cm. in length,* having 8 to 10 prominent ribs, light brown and frequently covered at the base with soft, woolly hairs The flower stalk is from 15 to 40 cm. in length, having 8 to 10 prominent ribs, olive-green when young, usually covered with soft woolly hairs, which are easily detachable, leaving the stems glabrous. The stem leaves are alternate, the upper sessile, the lower petiolate, having a lanceolate outline and usually *laciniate-pinnatifid.* The flowers are in open corymbs, the heads having slender peduncles which vary from 3 [illegible] *linear, erect-connivent;* ray florets 8 to 1[illegible] tubular florets yellow and perfect; a[illegible]s, about 6 mm. in length; the odor is [illegible]d somewhat bitter and pungent.

The epidermal cells have undulate walls, the stomata being *narrowly* elliptical [illegible] to the pore; [illegible]ving 2 to 4 [illegible]undles; the [illegible] the fibro-stems show a strong development of collenchyma at the [illegible] vascular bundles are arranged in a closed ring, each being surrounded by a strong development of fibers, the pith is hollow. The woolly hairs of the stems and petioles are very long, thin-walled and up to 40 *microns in* width; the non-glandular hairs on the leaves are few, uniseriate, about 250 microns in length

and consisting of 5 or 6 short, cylindrical cells, having thin walls and an oily content; the achenes are covered with club-shaped or spatulate hairs, about 180 microns in length and finely transversely or obliquely striate; the pappus is multicellular, having at the jointed portions, short, sharp-pointed cells.

Kelly and Lynn found 0.1 per cent of volatile oil and about 8 per cent of inulin, but no evidence of either alkaloids or glucosides. Senecio is said to be a stimulant, a diuretic and an emmenagogue, no evidence has, however, been found of its having any uterine effect.

Senecio jacobæa, indigenous to Europe and Asia and localized to some extent in the New England States and Canada, and *S. vulgaris* somewhat resemble *Senecio aureus*. They are said to contain a mixture of alkaloids, senecionine and senecine; a volatile oil, 0.98 per cent of a fatty substance, soluble in ether, 0.88 per cent of a mixture of fatty acids, and 0.8 per cent of ash.

Lactuca Elongata or Wild Lettuce (U. S. P. 1820 to 1851) consists of the flowering herb of *Lactuca virosa* Linné.

Lactucarium (U. S. P. 1820 to 1926) is the dried milk juice of *Lactuca virosa* and other species of *Lactuca*, biennial herbs largely indigenous to central and southern Europe and cultivated in France, England and Germany, certain species being more or less naturalized in the United States.

Lactucarium is obtained by cutting off the tops of the stems, when the latex which exudes is partially hardened, it is collected and dried in hemispherical earthen cups until it can be cut into pieces, which are usually four in number, these being further dried.

It occurs in irregular, angular pieces or quadrangular sections, one surface of which is convex, externally dull reddish or grayish brown, fracture tough, waxy; internally light brown or yellowish, somewhat porous, odor distinct, opium-like, taste bitter.

Lactucarium is partly soluble in alcohol and in ether and about 50 per cent soluble in water, but the solution should not give a reaction for starch.

The powder is grayish brown to dark brown and consists of irregular and rather angular masses, with alkalis they become reddish brown and then a dirty brown, with sulfuric acid they are but slightly affected.

The drug contains three bitter principles: lactucin, which occurs in white rhombic prisms that are sparingly soluble in water, lactucopicrin, a brown, amorphous, very bitter principle which is readily soluble in water and alcohol, and lactucic acid, a yellow, very bitter substance crystallizing with difficulty and colored red by alkalis. The drug also contains about 50 per cent of a colorless, odorless and tasteless crystalline principle, lactucerin (lactucone), β- and α-lactucerol in the form of acetates, volatile oil, mannitol, organic acids, as citric, malic and oxalic and from 6.5 to 10 per cent of ash, nearly all of which is acid-insoluble.

A mydriatic alkaloid has been found in *Lactuca virosa* and in *L. muralis*.

Lactucarium is said to have some hypnotic effect, also it is very feeble. It is generally stated to be a sedative, a diuretic and an expectorant.

ALLERGENIC PREPARATIONS

Pollinosis, commonly called hay-fever, is an allergic manifestation produced in hypersensitive individuals by the pollen grains of certain plants. These allergenic pollens are wind borne and sufficiently light to be carried great distances. Not all wind-borne pollens are capable of producing allergic response. The chief factor in pollen allergy is the ability of pollen grains to stimulate [illegible] immune antibody in [illegible] susceptible persons.

The most popular method [illegible] pollens is by the periodic injection of [illegible]

petrolatum, or glycerin jelly to atmospheric currents for twenty-four hours. Protection from rain must be provided. The slide is then examined microscopically to identify and count the pollen grains which have lodged on the adhesive s[illegible]
smooth, ot[illegible]
to identify[illegible]
number of[illegible]
exposure is used as a basis for comparison in each locality. The number of grains per square centimeter of s[illegible] ns per cubic yard of air by the use of [illegible] Cocke. Daily atmospheric pollen count [illegible] on for the larger [illegible]
America. [illegible]
The Open [illegible]
is an air filter devised by Erdtman.

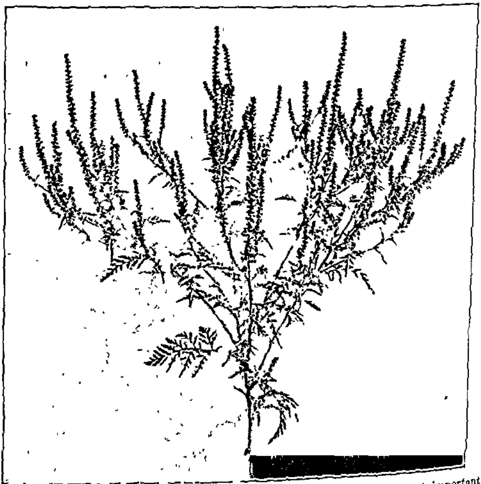


FIG 361.—Common or Short Ragweed, *Ambrosia artemisiæfolia*, the most important cause of hay-fever. (Photo, courtesy of Abbott Laboratories.)

[illegible] States, spring [illegible] e fever) produced by grass pollens; and late summer [illegible] plants pollens of ragweed and other weeds. The flowering seasons of these overlap in the southern and southwestern states, and it is difficult to apply a descriptive term for seasonal pollinosis.

The elms (*Ulmus*), the maples (*Acer*), the oaks (*Quercus*), the walnuts (*Juglans*), the birches (*Betula*), the poplars (*Populus*), the alders (*Alnus*), the willows (*Salix*), the hackberries (*Celtis*), and many other trees flower early in the spring.

Bermuda grass (*Cynodon dactylon* [L.] Pers.), Johnson grass (*Sorghum halepense* [L.] Pers.), orchard grass (*Dactylis glomerata* L.), sweet vernal grass (*Anthoxanthum odoratum* L.), red top (*Agrostis alba* L.), timothy (*Phleum pratense* L.), and June grass (*Poa pratensis* L.) are a few of the many grass pollens capable of causing an allergic response. Certain members of the *Chenopodiaceæ*, *Plantaginaceæ*, *Polygonaceæ*, *Amaranthaceæ*, *Compositæ*, and other families develop their flowers from mid-summer to the end of the growing season and produce allergenic pollens.

Of the *Compositæ*, the ragweed genus (*Ambrosia*) is responsible for approximately 90 per cent of the pollen allergy in the United States. Tall ragweed, giant ragweed, or great ragweed (*Ambrosia trifida* L.) is a coarse annual which sometimes grows to a height of 15 feet. The staminate flowers are borne in terminal spikes at the base of which are the pistillate flowers. The leaves are opposite and long-petioled. The lower leaves are more uniformly three-lobed than the upper.

Dwarf ragweed, common ragweed, short ragweed, or hogweed is known by the name *Ambrosia artemisiifolia* L., although recently taxonomists have suggested that this plant is synonymous with *Ambrosia elatior* L. Short ragweed is a much-branched annual which occasionally grows 6 feet high. It is characterized by its numerous staminate spikes and by its fern-like leaves which are once- or twice-pinnatifid. Short ragweed, as well as tall ragweed, occurs chiefly in the northeastern, middle Atlantic, and central states. Two other important species are the southern ragweed (*A. bidentata* Michx.) and the western ragweed (*A. psilostachya* DC.). Other fall-blooming genera are false ragweed (*Franseria*), the prairie ragweeds (*Iva*, *Cyclachæna*), cocklebur (*Xanthium*), and wormwood (*Artemisia*) which produce pollens of equal potency.

Pollen may be collected from plants in the following manner: cut the stems 12 to 18 inches below the flowering heads, place them in a pan of water so that the heads hang over the edge, collect the pollen on glazed paper placed beneath the heads. The following morning considerable pollen will have been shed onto the paper. An equal or larger yield will be obtained on the second morning and a smaller one on the third morning. Finally, the plants are shaken vigorously to remove the remaining ripe pollen, and then are discarded.

The dried pollen is defatted with ether and extracted with saline solution. Glycerin or dextrose is added to serve as a stabilizer in the preservation of the extract. The resulting solution is filtered by suction or pressure to render it sterile, and is then assayed for the number of units of nitrogen per cc. The finished extract is marketed in vials with the potency indicated on the label. Individual doses may be supplied ready for dilution and injection.

Recent investigators have indicated that water-soluble proteins of pollen grains are the allergenic factors. When the individual absorbs the protein of a pollen he becomes hypersensitive to that protein. The subsequent absorption of some of the same protein, even though in smaller amounts, creates a sudden reaction or shock accompanied by urticaria, lacrimation, sneezing, or inflammation of the sinus membranes. Susceptibility is determined by skin tests. An extract of the pollen is injected into the subcutaneous layers of the arm and the resulting reaction is compared with a control spot. A wheal or redness signifies a positive reaction and indicates that the person is allergic to the pollen and should be desensitized.

Treatment is co-seasonal although desensitization is best accomplished

by pre-seasonal or annual treatment. Extreme care must be used in determining the dosage for each patient. Sensitivity varies greatly and an overdose may cause disagreeable or alarming symptoms or even death.

Investigations have proved that the spores of molds, mildews, and other fungi are also important causes of allergy. Mold extracts, like

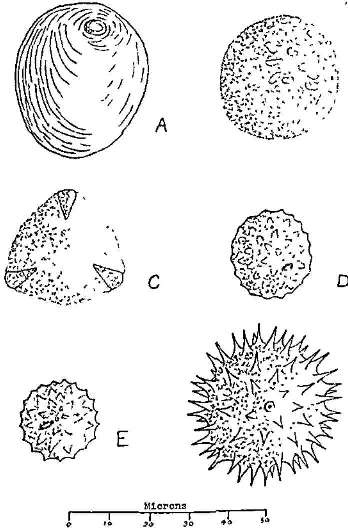


FIG. 362.—Pollen grains *A*, Sweet vernal grass. *B*, Cottonwood. *C*, White oak. *D*, Short ragweed. *E*, Giant ragweed *F*, Goldenrod.

pollen extracts, are used ... and to produce desensitization. Pollens, ... d dusts are inhalant allergens. Contactant allergens ... thers, hair, poison ivy, and poison sumac. The latter are discussed on page 405. Ingestant allergens such as strawberries, tomatoes, eggs, cheese, wheat, and other protein foods have been extracted. These extracts are used chiefly as diagnostic agents to determine susceptibility.

ANIMAL DRUGS

The taxonomy of animals is similar to that of plants. The animal kingdom is divided into sub-kingdoms or phyla and these in turn into classes, orders, families, genera and species. Since the number of drugs derived from animals is much smaller than the number derived from plants, only a very brief survey of some of the phyla will be presented here. Those phyla yielding no drugs will be omitted.

Protozoa are 1-celled animals such as the *Amœba*, *Paramœcium* and *Vorticella*. The order *Foraminifera* contains animals the shells of which comprise the natural chalk deposits of Cornwall and other parts of the world. While these shells are composed largely of calcium carbonate they also contain more or less silica, aluminum, magnesium and organic matter. **Creta Præparata, Prepared Chalk,** U. S. P. 1820 to date is obtained by elutriation from this native chalk.

Porifera are animals having many similar cells arranged about a common cavity, the food entering the body through numerous openings. To this phylum belong the sponges.

Spongia or Sponge, and Spongia Usta or Burnt Sponge (U. S. P. 1820 to 1863) consist of the fibrous framework of *Espongia officinalis*. Sponges grow in the sea, attached to rocks and are very often planted in beds for cultivation. When full grown the sponges are torn from the rocks and buried in the sand to disintegrate the gelatinous animal matter which is removed by washing. There are several commercial varieties, among which the following may be mentioned: (1) Mediterranean, Turkey, (2) Zimocca (coast of Greece); (3) Bathing (coast of North Africa), (4) Sheep's Wool (coast of Florida and the Bahamas). Sponges are used mechanically for cleaning and washing and for absorbing liquids. *They have been used in dilating cavities (sponge tents) and as pessaries in* dysmenorrhea.

Cœlenterata are animals having hollow cylindrical bodies with one opening, the mouth. To this phylum belong the hydras, hydroids, jelly-fish, corals and the sea-anemones. The corals are animals having a calcareous skeleton which is more or less branched. It is on these branches that the individual animals are found in tube-like apertures. *The calcareous skeleton* **(coral)** *has been used to some extent in tooth*-powders as an antacid.

Platyhelminthes is the phylum containing the tapeworms and the phylum **Nemathelminthes** the threadworms, trichina, hookworm, etc., all these are of interest as parasites of the human body.

Annulata are worm-like animals. To this phylum belong the earthworm and the leeches.

Three leeches *have been used in medicine*: the Speckled, Green or Gray Leech (*Hirudo medicinalis*), a native of northern and central Europe, the Australian or Five-striped Leech (*Hirudo quinquestriata*) and the American Leech (*Hirudo decora*). Leeches are from 6 to 12 cm. long, dorsoventrally flattened and show about 100 rings or annulations. The anterior end has a cup-like sucker in the center of which is the mouth with three radiating jaws provided with many chitinous teeth with which the leech produces its characteristic triradiate bite.

Leeches live in ponds, marshes and running streams in practically all temperate climates. They should be kept in water in jars which are tightly covered

with a linen cloth. The water should be changed once or twice each week and occasionally gravel or sand may be added so that the animals may clean themselves of the slime which accumulates on their bodies.

Although used mu [illegible]
local congestions or [illegible]
tured and the blood [illegible]
the application is to be made should be cleansed and freed from hair and if it be advisable to localize the bite a piece of moistened filter paper with a small hole may first be applied to the area. Leeches withdraw from 5 to 10 cc. of blood and may be removed by sprinkling them with salt. The bite continues to bleed for a considerable time, due to the fact that the salivary glands of the leech produce a substance known as *hirudin* which retards the coagulation of the blood. The use of the same leech for different patients should be discouraged due to the danger of carrying infection.

Mollusca are soft-bodied animals often enclosed in hard shells. To this phylum belong clams, snails, the nautilus, the squid and the cuttlefishes.

[illegible]

rises to the surface of the sea after the death of the animal and may be collected. Cuttlefish bones are quite common on the shores of Europe and the Indian Ocean. In common with the other squids the cuttlefish possesses an ink gland, and from this is obtained the dye used in water colors and known as sepia. Cuttlefish bones are oblong-ovate and more or less biconvex, up to 25 cm. long, 7.5 cm. wide and 2 cm thick. The outer portion is hard but the inner part is porous and friable. Cuttlefish bone contains from 80 to 85 per cent of calcium carbonate and has been used as an antacid; in tooth and polishing powders, for caged birds to sharpen their bills against; and as an abrasive.

Oyster-Shell (U.S P. 1831 to 1882) is the inner white layer of the shell of the oyster (*Ostrea virginiana* and other species of *Ostrea*). Oysters are bivalves which inhabit the shores of the Atlantic and the Indian Oceans In the preparation of **Prepared Oyster Shell** (U. S. P. 1831 to 1882) for medicinal use, the shells are boiled, and the outer layer removed; then the inner layer is powdered, the coarser particles being separated by elutriation. Oyster-shell consists mostly of calcium carbonate (88 to 98 per cent) and has been used as an antacid

Arthropoda are animals having segmented bodies and jointed appendages. To this phylum belong the insects (see below).

Vertebrata or **Chordata** are animals having a backbone made up of parts called vertebræ. To this phylum belong fishes, frogs, turtles, snakes, birds, horses and man. Older classifications divided the animal kingdom into two sub-kingdoms, *Invertebrata*, including the previously discussed groups, and the *Vertebrata*.

As the insects and vertebrates (see page 662) yield a number of important drugs, these groups will be discussed at greater length.

CLASS INSECTA

This class includes those small animals which have 1 pair of antennæ, 3 pairs of mouth organs, 6 legs, 1 or 2 pairs of wings and breathe air by means of tracheæ extending from openings, called spiracles, on the sides of the body. The bodies of the insects are divisible into three distinct parts, the head, the thorax and the abdomen. Examples of the group are grasshoppers, dragon-flies, moths, beetles, flies, etc.

ORDER HEMIPTERA, FAMILY COCCIDÆ

This order includes insects having suctorial mouth parts. The wings are two or four in number and are usually membranous. The insects feed on plant juices and animal blood. The group includes the squash-bug, bed-bug, plant lice and the scale insects

The *Coccidæ* include the scale insects and bugs which are injurious to plants. The members of the family differ greatly from the members of other families in this order and also often show considerable variation among themselves. The males undergo complete metamorphosis and possess only one pair of wings. The female has no mouth parts and is always devoid of wings It is usually covered with scales which form a protective case.

COCHINEAL

Cochineal or Coccus (U. S. P. 1831 to date; *in test solution*, U. S. P. 1894 *to* 1936, N. F. 1936 *to date*) consists of the dried female insect, *Coccus cacti* Linné, enclosing the young larvæ. The generic name *Coccus* is from the Greek *Kokkos*, meaning a grain or berry and refers to the appearance of the insect; *cacti* is from the Greek *Kaktos*, meaning a prickly plant, the insects being cultivated on various species of cactus

... on various species of the *Cactaceæ*, more espe- ... *cochenillifer* (*Opuntia coccinellifera*), a native ... read in Central and South America and has been introduced into the West Indies, East Indies, Canary Islands, southern Spain and Algeria and is said to be found in Florida and California

The female insect is without wings, about 2 mm. in length and consists of from 9 to 12 segments It is somewhat globular ... listinctly ovoid In general appearance, as it ... convex on the upper (dor... It is covered with a ... ued as a glandular secretion by the "w... ...), and wax hairs The antennæ are rather short, consisting of 8 parts The thread-like beak or proboscis, forming a sucking apparatus, is very fully developed There are 3 pairs of legs and projecting from the posterior portion of the abdomen there are 2 short ... The female insect after fecundation ... becoming eventually ...

... about 5 mm in length, dark garnet in ... part of the insect with a more or less developed beak or rostrum is always present, the beak sometimes being extended and recurved in an elliptical form in the direction of the abdomen One or both of the antennæ are frequently present, showing 5 to 7 parts The joints of the legs are usually more or less detached, the point of insertion usually being indicated only by large yellowish brown elliptical scars Between each of the legs on both sides are situated 2 distinct pores, which resemble in form and color the point of attachment of the legs and which are respiration canals In the abdominal region, which is very large, the larvæ are borne These are usually seen to be in several stages of development (Figs 363, 364 and 365).

The following method is useful in destroying the coloring matter, thus rendering it possible to study the cochineal insect, 10 gm of commercial cochineal

is macerated with 100 cc. of water containing 2 or 3 per cent of an alkali. The mixture is allowed to stand for an hour or so and then is poured over a piece of wire gauze. The insects remain on the gauze and are then washed with a few

showing an ovoid sac-like mem-
ts of the mother insect; m,
of legs; r, respiration channels
-pores.

liters of water The insects, from which the *coloring* matter has been partly *removed*, are then transferred to 150 cc. of *hydrogen peroxide* solution and *allowed to stand* for a few hours with occasional gentle stirring. The *mixture*

is again transferred to the gauze, the excess of hydrogen peroxide washed off and the insects then transferred to a weak alkali solution in which they are macerated for six or eight hours The mixture is poured upon the wire gauze

Fig. 364 —Photomicrograph of several of the numerous larvæ found in the mother insect and in which are to be seen the characteristic beaks (b), and the three pairs of legs (f) still enclosed in the sac-like membrane of the larva

and washed with water until the filtrate runs practically colorless The insects on the gauze are then transferred to dilute alcohol to which a few drops of hydrochloric acid have been added This now renders them translucent and ready for microscopic study They may be mounted in chloral T S. and examined

CONSTITUENTS.—From 9 to 10 per cent of a glucosidal coloring principle, carminic acid (carmine red). It is methyldioxy-naphthoquinone and forms crystals, which are very soluble in water, alcohol and ammonia, partly soluble in ether, and insoluble in fixed and volatile oils. Cochineal also contains 0.5 to 4.2 per cent of a wax, coccerin; from 1.5 to 2 per cent of myristin; from 4 to 6 per cent of a mixture of fats and fatty acids; total ash, from 0.5 to 6 per cent, with about 0.5 per cent insoluble in diluted hydrochloric acid.

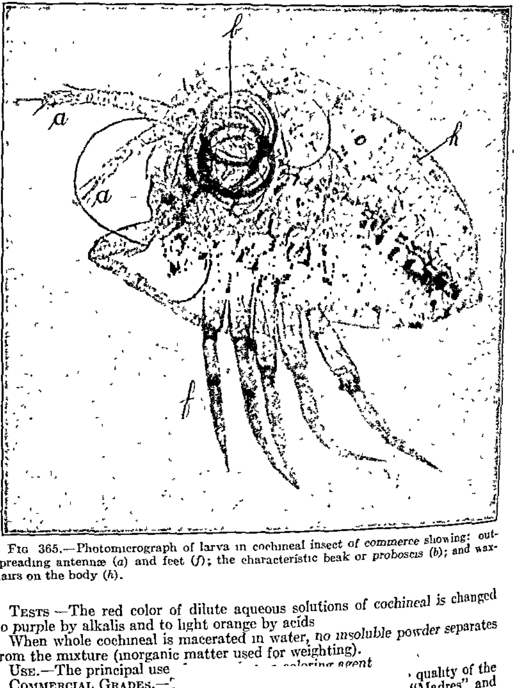


FIG 365.—Photomicrograph of larva in cochineal insect of commerce showing: outspreading antennæ (a) and feet (f); the characteristic beak or proboscis (b); and wax-hairs on the body (h).

TESTS —The red color of dilute aqueous solutions of cochineal is changed to purple by alkalis and to light orange by acids

When whole cochineal is macerated in water, no insoluble powder separates from the mixture (inorganic matter used for weighting).

USE.—The principal use ... coloring agent ... quality of the

COMMERCIAL GRADES.— ... "Madres" and

commercial article The r... ipped the best

represents the first brood of ... y comes from

commercial article. At the present time, ...

Teneriffe, one of the Canary Islands.

According to the fancy of the broker or exporter, several grades of cochineal are recognized Broadly speaking, the terms "silver grain," "black grain" and "granilla" are used, but there are intermediate qualities variously designated as gray, black-gray, silver-gray, silver-black, rosy black, red and foxy, and these again may be qualified by the terms fair, bold, fine and so forth. The commercial variety known as "granilla" represents the smaller females in which the larvæ usually show but a very slight development.

"Silver grain" is prepared by drying the insects in trays in the sun, or in an oven at a moderate temperature (about 65° C) for four or five hours and subsequently in the sun so that the waxy substance is not melted and the color is whitish with a silvery sheen If they are dried at a higher temperature than 106° C., the melting-point of the wax, on hot iron plates, the black grain is the result. The red tint of the rosy black is said to be produced if they are put in bags and dipped in boiling water to kill them before drying and that of the foxy silvery grain is produced by sifting the insects when not perfectly dry so that some of the coloring matter tinges the surface The black grain usually obtains a higher price than the silver grain Both the black and silver grain are sometimes adulterated to meet the demand for a cheap article The black grain is sometimes met with having the concave side filled with grains of a magnetic iron sand. The silver grain is said to be weighted with sulfate of barium or carbonate of lead and the very white appearance is given by powdered talc or other white powder

Carmine (N. F. 1916 to date; as a coloring agent U S. P. 1916 to 1926) is the aluminum lake of the coloring principle obtained from cochineal. Carmine occurs in irregular, angular, bright red fragments or as a powder, without odor or taste. When burned it emits an odor resembling that of burned feathers. Carmine is slightly soluble in ammonia water or alkaline liquids, forming a dark purplish red solution It should not contain more than 25 per cent of water and not more than 12 per cent of ash and should be free from tin, lead, and soluble and insoluble barium compounds. Consult the National Formulary for methods of testing.

USES —Carmine is a coloring agent.

ALLIED INSECTS AND PRODUCTS —**Kermes** is a dye produced from *Coccus ilicis* inhabiting *Quercus coccifera*, a native of Greece

Lac or Shellac is a resinous secretion produced on the bodies of *Lakshadia indica* or other species of *Lakshadia* Shellac is produced in Burma and India, the insects being cultivated on various plants. The insects resemble cochineal in structure and life history The secretory glands secrete wax in such quantities that it completely covers the insects and the twigs Such twigs broken off constitute **stick lac**; a purified form from which the dye has been exhausted is known as **seed lac** and a melted form which is poured on plates is known as **flake lac, or shellac**, the latter being the most commonly occurring form in commerce Shellac contains about 85 per cent of resin Shellac is used in varnishes, polishes, sealing wax, etc.

ORDER COLEOPTERA, FAMILY MELOIDÆ

This order includes insects having four wings, the posterior pair being membranous and sheathed by the hardened anterior pair. These hardened anterior wings are called elytra, and when folded together nearly cover the body The mouth parts (mandibles and maxillæ) are well developed Metamorphosis is indirect. To this order belong the firefly and the various kinds of beetles.

The *Meloidæ* possesses five tarsal joints on each of the front and middle legs. The hind pair have four joints and claws. The integument is rather soft.

CANTHARIDES

Cantharides, Spanish Flies, Russian Flies or Blistering Flies (U. S. P. 1820 to 1942; N. F. 1942 to date) consists of the dried insects, *Cantharis vesicatoria* (Linné) De Geer. *Cantharis* is a Greek word meaning a beetle, *vesicatoria* is from the Latin *vesica*, a bladder, in allusion to the blistering qualities. This insect is found upon certain shrubs of the *Caprifoliaceæ* and *Oleaceæ*, growing in southern and central Europe. The mature insects usually make their appearance in June or July. In the early morning, when the insects are still sluggish from the cold night air, the shrubs are shaken or beaten with poles and the insects collected upon cloths spread on the ground. The insects are killed by plunging them into dilute vinegar, or exposing them to the fumes of hot vinegar, ammonia, sulfur dioxide or by means of chloroform, ether or similar drugs. After this they are carefully dried at a temperature not higher than 40° C. Keep the drug in tight containers and add a few drops of chloroform or of carbon tetrachloride occasionally to preserve the drug from attack by other insects. The commercial supplies are obtained chiefly from southern Russia, Hungary and Spain and to some extent from Roumania, Poland and Sicily.

Spanish fly apparently came hand in hand with medical cruelty and was an heirloom of ancient heroic medication. Hippocrates describes its use in dropsy as early as 375 B.C.

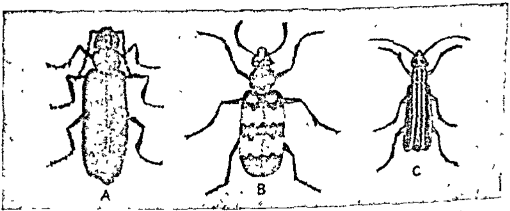


FIG. 366 —*A*, *Cantharis vesicatoria*; *B*, *Mylabris cichorii*; *C*, *Cantharis vittata*. (After Snyder.)

DESCRIPTION.—(Fig 366 *A*. ... from 1.5 to 2.5 cm. in length and 4 to 8 mm. in ... or bluish green ... triangular, ...

green metallic luster and possessing 2 parallel lines; under surface brown; wings 2, membranous, transparent, light brown and longer and broader than the elytra; odor distinct, penetrating and disagreeable; taste at first slight, afterwards pungent and very acrid.

POWDER.—Grayish brown, with shining green particles (see Fig. 367).

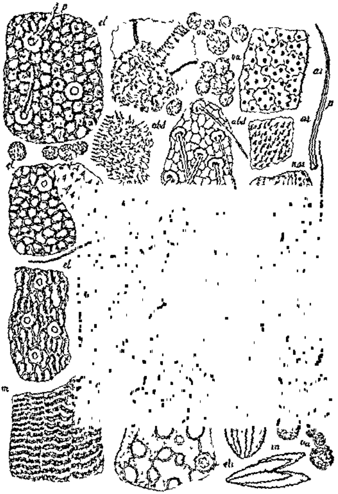


FIG 367 —Powdered Cantharides fragments representing the abdomen (*abd*), the ... thorax and wings (After Collin)

CONSTITUENTS —The vesicating principle, cantharidin, 0 4 to 0 8 per cent, ... colorless prisms, without ...hol, carbon disulfide and

stearic,
found.

Standards.—Cantharides yields not less than 0.6 per cent of cantharidin and not more than 10 per cent of moisture.

Uses and Dose.—*Cantharides is an irritant, a vesicant, and rubefacient. It* probably should never be taken internally, as it has the same irritant and vesicant action upon the mucous membrane and comparatively small quantities tend to produce nephritis. Internally it has been given as a diuretic, also as an aphrodisiac.

Allied Drugs.—**Mylabris or Chinese Blistering-flies,** are *obtained from Mylabris cichorii*, indigenous to the East Indies and China. They are elongated, oval or cylindrical (Fig. 366), from 1.8 to 2.5 cm. in length and from 4 to 11 mm. in breadth; elytra or wing-sheaths black, with 2 broad brownish *yellow*, occasionally golden yellow bands and at the anterior portion a pair of nearly circular brownish yellow spots; heads somewhat triangular and of a jet-black color, *mandibles stout and large, partly concealed; antennæ clavate, 11-jointed; eyes* large and compound; prothorax wedge-shaped, black; the femora of first and second pairs of legs are covered with yellowish hairs, while the third pair are nearly glabrous and black; odor and taste resembling cantharides.

The powder of mylabris is dark brown and contains numerous, slender, sharp-pointed, blackish hairs, from 200 to 600 microns in length and about 30 microns in width at the base.

Cantharis Vittata (U. S. P. 1820 to 1863), known as the **American Blistering Beetle or Potato Fly,** has pronounced vesicating properties. It is smaller than *C. vesicatoria* and the elytra are black, having a median and marginal yellow stripe.

ORDER HYMENOPTERA, FAMILY APIDÆ

This order includes insects of the highest structural development and instinctive faculties. They have four membranous wings, the anterior pair being the larger. The mouth parts are adapted for both sucking and chewing. Metamorphosis is complete. To this order *belong bees*, gall-flies, wasps and ants.

The Apidæ is a large family characterized by possessing short, stout mouth parts. The posterior tibiæ are devoid of apical spurs. To this family belongs the bees.

HONEY

Honey, Mel, *Clarified Honey or Strained Honey* (U. S. P. 1920 to 1947, N. F. 1947 to date) is a saccharine secretion deposited in the honeycomb by the bee, *Apis mellifera* Linné. The generic name *Apis* is Latin for bee, and *mellifera* is from two Latin words meaning to bear honey. Honey bees live in swarms consisting of from 10,000 to 50,000 individuals. The swarms are usually gathered into hives, the bees being thus cultivated for both honey and wax. The individuals may be *divided into three classes depending* upon differentiation in form and function; thus a hive contains (1) a single queen bee, the fertile *female*, (2) the males or drones, and (3) the undeveloped females or *neuters*, which are the working bees. The worker possesses a *long, hollow tube* formed from the maxillæ and labium, which they insert into *the nectaries* of the flowers. The nectar, consisting largely of sucrose, *is thus drawn* up and finds its way through the œsophagus into the *honey-sac*, where *through the action of salivary* enzymes it is converted into invert sugar. Upon arrival at the hive the worker deposits the *contents of the honey-sac* into a special cell of the comb. The *beginning* of bee-culture is lost

in antiquity. The ancient Egyptians placed their hives on rafts, floating them up and down the Nile in accordance with the locality having the most flowers in bloom. Today honey is produced in almost all temperate and tropical countries Bee farming is an important industry in the United States and Canada. The honey is separated from the wax cells of the honeycomb by expression and straining or by centrifuging.

DESCRIPTION.—A thick, syrupy liquid of a light yellowish or yellowish brown color. It is translucent when fresh but often becomes opaque and granular due to the crystallization of dextrose. It has a characteristic odor and a sweet, faintly acrid taste, the odor and taste varying somewhat depending upon the floral source of the product Microscopically honey exhibits pollen grains by means of which its floral source may often be established.

CONSTITUENTS.—Principally invert sugar, 50 to 90 per cent, and water Honey also contains from 0.1 to 10 per cent of sucrose, and small quantities of dextrin, volatile oil and formic acid.

STANDARDS AND TESTS.—Honey must be free from foreign substances such as parts of insects, leaves, etc., but may contain pollen grains. Its specific gravity should be not less than 1.099 at 25° C, it should yield not more than 0 3 per cent of ash and it should be free from starch, dextrin, foreign coloring matter, azo dyes, artificial honey or added invert sugar. Consult the National Formulary for tests and methods. Dextrose and levulose may be demonstrated in honey by the formation of their respective phenylosazones

USES.—Honey is a nutrient and a demulcent It is also used as a vehicle similar to syrup, although it possesses more of a laxative action than syrup. Pharmaceutically it finds some use as a pill excipient

ADULTERANTS.—The most common adulterants of honey are artificial invert sugar, sucrose and commercial liquid glucose.

Yellow Wax or **Beeswax** (U S. P. 1820 to date) is the purified honeycomb of the bee, *Apis mellifera* Linné. Wax is secreted in cells on the ventral surface of the last four segments of the abdomen of the worker bees. The wax excretes through pores in the chitinous plates and is employed by the young worker bees in the construction of the comb.

The honeycomb after separation from the honey is melted in water, then cooled and remelted, and finally strained and allowed to harden in molds.

DESCRIPTION —Beeswax is a solid varying in color from yellow to grayish brown It has an agreeable honey-like odor, and a faint characteristic taste When cold it is somewhat brittle and exhibits a dull, granular, non-crystalline fracture Consult the U S Pharmacopœia for characters and tests.

CONSTITUENTS —Myricin, about 80 per cent, which consists chiefly of myricyl palmitate, myricyl stearate, cerotic acid, about 15 per cent, and cerolein

USES —Yellow wax is used as a base for plasters, cerates and ointments It is also used in polishes

ADULTERANTS —Fats, fatty acids, Japan wax, rosin, soap and carnauba wax. (Consult the U S Pharmacopœia for methods of detection)

White Wax or **Bleached Beeswax** (U S P 1820 to date) is bleached yellow wax This is accomplished by allowing the melted wax to flow slowly over revolving wetted cylinders, upon which it hardens in thin ribbon-like layers These are removed and exposed to sunlight and air until bleached, the process usually being repeated, the bleached wax finally being melted and cast into cakes of various shapes. Consult the U. S Pharmacopœia for characters and tests.

USES.—White wax is employed pharmaceutically in *simple cerate and in* cold creams.

VERTEBRATA.—See discussion on page 652.

CLASS PISCES, FAMILY GADIDÆ

This, the first class of the vertebrates, includes those oviparous animals which are adapted to life in the water. The majority of fishes have a bony internal skeleton and a scaly protective exo-skeleton. They have a complete cranium and respiration takes place by means of gills. There are two orders: (1) the *Teleostei* or bony fishes and (2) the *Dipnoi* or lung fishes.

The *Gadidæ*, order *Teleostei,* include a number of valuable food fishes such as haddock, codfish, etc.

COD LIVER OIL

Cod Liver Oil (U. S. P. 1851 to date) is the partially destearinated fixed oil obtained from the fresh livers of *Gadus morrhua* Linné and other species of the Family *Gadidæ.* The generic name *Gadus* is from *gados*, the Greek name of the codfish, and *morrhua* is the Latin name of the codfish. Codfish inhabit the North Atlantic Ocean, coming to its shores to spawn in the late winter and spring.

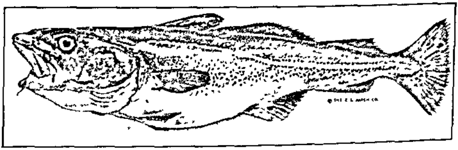


FIG. 368.—The Cod, Gadus morrhua. (Courtesy of the E. L. Patch Co.)

The principal fishing grounds are from New England north to Nova Scotia and Newfoundland and along the coast of Norway. Fishing is carried out by trap nets, hand-lines or set-lines. In the early days the fish were cleaned on ship-board, the edible portion being salted and the separated livers thrown into barrels, where through a process of "rotting," the tissue disintegrated and the oil rose to the top. Today, for the production of medicinal oil, the fish are brought to the fish-houses within a few hours after being caught, the livers are removed with care and the gall-bladder is completely separated. The livers are steamed in closed kettles and the oil rises to the top, where it is collected. The air above the oil is replaced by carbon dioxide to prevent oxidation. The oil is strained, filled into tin-lined containers and chilled to a temperature below $-5°$ C. During this chilling process the stearin separates out as a solid and the lighter oil is decanted and filtered. Finally the

oil is adjusted to a definite vitamin content by admixture, if necessary of different lots of the oil having higher and lower vitamin values. The liver-marc is often resteamed and pressed for a further yield of oil which is used for technical purposes.

Cod liver oil was exported from Norway as early as the Middle Ages. Its use, however, was for technical purposes only. It was introduced into medicine during the middle of the eighteenth century.

DESCRIPTION.—Cod liver oil is a thin
fishy, but not rancid odor and a fishy
but freely soluble in ether, chloroform,

CONSTITUENTS.—The medicinal const
d vitamin D (the
unsaturated (about
The unsaturated
acids include oleic, linoleic, gadoleic and palmitoleic and the saturated acids include myristic, palmitic and traces of stearic (Bile salts, and the alkaloids

copœia.

STORAGE.—Cod liver oil should be preserved in a cool place, in well-closed containers which have been thoroughly dried before filling Cod liver oil may

promoter" in children. Average dose infants, 4 cc , adults, 8 cc

Non-destearinated Cod Liver Oil (U. S. P 1936 to date) is the crude cod liver oil that has not been chilled so as to separate the stearin. It is permitted to contain not more than 0.5 per cent by volume of water and liver tissue, and it deposits stearin upon chilling, but in all other respects responds to the standards prescribed in the U S. Pharmacopœia.

HALIBUT LIVER OIL

Halibut Liver Oil (U. S P. 1942 to date) is the fixed oil obtained from the fresh or suitably preserved livers of the halibut, *Hippoglossus hyppoglossus* L. The name halibut is from *hali* meaning holy and *butte* meaning flounder and refers to a flounder eaten on holy days. The term *hippoglossus* is from the Greek *hippos* meaning horse and *glossus* meaning tongue, and refers to the flat shape of the fish. The halibut inhabits the oceans of the northern hemispheres where commercial fishing is

carried on by hand—or set-lines. The livers are processed much the same as cod fish livers.

Description.—*See the U. S. Pharmacopœia.*

Constituents.—The principal constituents of Halibut Liver Oil are vitamins A and D. Olein, palmitin and cholesterin make up the body of the oil.

Standards and Tests.—Halibut Liver Oil contains in each gram *not less* than 60,000 U. S. P. units of vitamin A and not less than 600 U. S. P. units of vitamin D. For further standards and tests see the U. S. Pharmacopœia.

Uses and Dose.—Halibut Liver Oil is used for the same purposes as cod liver oil. Its high vitamin potency permits it to be administered in much smaller doses. Gelatin capsules comprise the usual dosage form. The dose is 0.1 gm. as a prophylactic in both infants and adults.

Allied Drugs.—**Burbot** [illegible] burbot *Lota maculosa* (Fam. [illegible] Liver Oil has a potency of [illegible] not less than 640 U. S. P. units of vitamin D, *per gram.*

Shark Liver Oil (NNR) is extracted from the livers of the shark, principally from the lemon shark *Hypoprion brevirostris*, although any of the following varieties of shark may be the source of the oil: sand shark, *Odontaspis littocalis;* mackerel shark, *Isurus punctatus;* leopard shark, *Triakis semifasciatum;* ham- [illegible] 16,500 U. S. P. units of vitamin A, and not less than 40 U. S. P. units of vitamin D, per gram.

Percomorph Liver Oil (NNR) is a mixture of the fixed oils obtained from the fresh livers of the percomorph fishes. The term percomorph is from the Latin *perca* meaning perch and *morph* meaning form, thus a perch-like form. The *Percomorphi* comprise an extensive order of fishes including the perches, basses, mackerels, tunnies, albacores, sword fishes, bonitos, sardines, snappers, groupers and weakfishes; in fact the order includes the majority of the spiny-finned fishes. The oil is obtained from the fresh livers in much the same way [illegible] *Xiphias* [illegible] ugh [illegible] ains [illegible] han 60,000 U. S. P. units of vitamin A and not less than 8500 U. S. P. units of vitamin D per gram.

Several additional official and unofficial vitamin-containing drugs and preparations will be found in the section on vitamins (*see below*).

THE VITAMINS

Vitamins are organic compounds required for normal growth and maintenance of life of animals, including man. They do not *furnish energy and are not utilized as building units* for the structure of the organism, but they are essential for the regulation of the metabolic processes. They act in the form of enzymes during the metabolism of the energy-yielding food constituents.

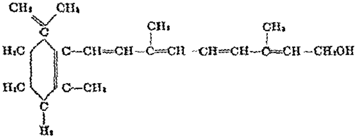
This definition of vitamins is not without criticism. The substances which we know as vitamins exert no vitamin activity as such, *but are* active only after chemical transformation into other compounds. Substances as thiamine, riboflavin and niacin are constituents of enzymes. In some cases the same "vitamin" may be part of different enzymes, each having a different catalytic activity. The *term* "vitamin" as

defined above has served a useful purpose and it would be more reasonable to adopt a special terminology for the enzymes containing these vitamins, than to change the present-day definition which in general has been adopted.

VITAMIN A

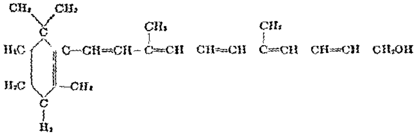
Vitamin A the anti-xerophthalmic vitamin, occurs in three or more forms, namely: Vitamin A_1 or Gadol, from cod liver oil and the liver oils of certain other salt water fish, Galol, a possible geometric isomer of vitamin A_1, from shark liver oil; vitamin A_2 from fresh water fish oils.

Vitamin A_1 and its isomer have the formula



Gadol occurs as yellow crystals, having a melting point of 62° to 64° C., and an absorption maximum at 328 millimicrons Galol occurs as pale yellow needles, having a melting point of 59° to 60° C, and an absorption maximum at 325 millimicrons

Vitamin A_2 has the formula



and an absorption maximum at 345 to 350 millimicrons

The three vitamin A forms are found in the unsaponifiable fraction of the fish oils; are resistant to heat in the absence of air, acids and alkalis, are destroyed by oxidation at all temperatures, and are unstable to light. They may occur as free alcohols or in the ester form

A group of Provitamin A substances or Carotenoids, including alpha-, beta-, and gamma-carotene, and cryptoxanthine, all of plant origin, are converted in the liver to vitamin A These compounds are dark red crystals, insoluble in water, acids or alkalis, and very sensitive to oxidation. In the biological assay of vitamin A, 0 6 microgram of pure beta-carotene used to be equivalent to one U. S P. unit Vitamin A (but not carotene) may be determined by the Carr-Price method, which is based on the blue color obtained with antimony trichloride. Carotene is measured by colorimetric comparison after chromatographic purification

The following biological functions of vitamin A may be listed.

1. It is specific in the prevention and cure of xerophthalmia and nyctalopia
2. Hyperkeratosis of the skin of certain types occurs when vitamin A deficiency is severe

3. *It is useful in overcoming retardation of growth and development when this is due to vitamin A deficiency.*
4. *It is of value for increasing resistance of the body to infection only when there has been an exhaustion of body reserves and an inadequate ingestion of vitamin A.*

DAILY REQUIREMENTS.—Adults 4000 to 5000 units; pregnant and lactating mothers 6000 to 8000 units; children 3000 to 5000 units; infants 1500 units.

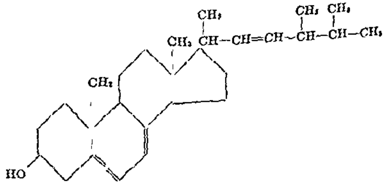
SOURCES OF VITAMIN A.—Fish liver oils, liver, egg yolk, cream, cheese, butter, milk; of Carotene: green leafy vegetables, apricots, carrots, sweet potato; of Cryptoxanthin: yellow corn, egg yolk.

FIG 369.—Two rats of equal weight were placed on a vitamin A starvation diet; one was fed cod liver oil, the other received none. (Photo, courtesy of Parke, Davis & Co.)

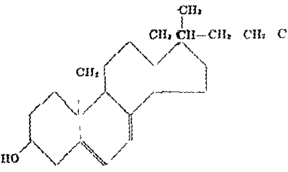
VITAMIN D

The antirachitic vitamin occurs in a number of forms. Four crystalline D vitamers have been isolated and at least 10 provitamins-D are known. They are either ergosterol (vitamin D_2) or cholesterol (vitamin D_3) derivatives. For humans most of the vitamin D activity is supplied from animal sources or from sunshine.

Vitamin D_2, Calciferol, Activated Ergosterol or Viosterol *is formed by exposing ergosterol to ultra-violet irradiation or other energy.* It is:



Vitamin D_3 is the natural vitamin D found in fish oils and formed in the skin of man and animals following exposure to sunlight. It may be formed by the irradiation of 7-dehydrocholesterol and has the following formula:



These vitamers are white crystalline substances, soluble in fats and organic solvents, and stable to heat and aeration. They exhibit characteristic absorption spectra with a maximum of 265 millimicrons. Vitamin D_2 melts at 115° to 117° C. and vitamin D_3 at 82° to 84° C.

The ultra-violet irradiation of ergosterol, a sterol of vegetable origin found principally in yeast and ergot, produces a series of chemical reactions yielding the following products: Ergosterol → Lumisterol → Tachysterol → Calciferol → Toxisterol → Suprasterols 1 and 2.

In the production of calciferol (viosterol, vitamin D_2) it is important that the conditions of irradiation are such that calciferol is produced to the exclusion of the toxic "over-irradiation" products such as toxisterol. In the early days certain of the irradiated ergosterol products were contaminated with toxisterol because of the failure to give proper consideration to the degree of irradiation. Products such as Ertron synthesized from vegetable sterols by electric energy are said to be free from the toxic sterols.

Drugs and foods are assayed for vitamin D by the rat curative line test. A color reaction with antimony trichloride and ultra-violet absorption are used for certain high-potency products, but in general are not applicable to food products.

Biological Functions.—Vitamin D aids in the utilization of calcium and phosphorus. It is essential to the development and maintenance of strong teeth and bones. Rickets in children and osteomalacia in adults are remedied and prevented by an adequate vitamin D intake. Vitamin D requirements are increased during pregnancy and lactation. One U. S. P. unit is equivalent to 0.025 microgram of crystalline vitamin D_2 (calciferol).

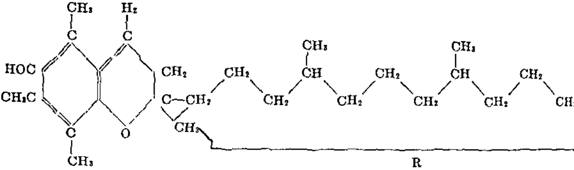
Daily Requirements.—Infants, 400 to 800 units, children, 400 units, pregnant and lactating women, 400 to 800 units, adults: for persons who have no opportunity for exposure to clear sunshine and for elderly persons, the ingestion of small amounts of vitamin D may be desirable. Other adults have little need for vitamin D in the diet. Vitamin D, in excessively large doses over prolonged periods of time, is said to be toxic.

Sources.—Cod liver oil and other fish liver oils; butter, cream and liver, milk and cereals fortified with vitamin D, the activating action of sunlight or ultra-violet light on the skin.

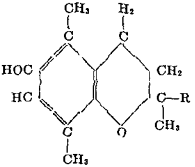
VITAMIN E

Vitamin E designates a group of substances having similar biologic functions. These are alpha-, beta- and gamma-tocopherol of which alpha-tocopherol is the most potent.

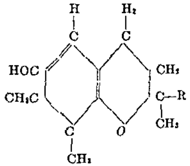
The structural formulæ are as follows:



Alpha-tocopherol



Beta-tocopherol



Gamma-tocopherol

All [illegible] ether stable and o[illegible] rancid fats. The esters of the tocopherols are more stable than the free alcohols. Tocopherols are used to stabilize vitamin A preparations.

One International Unit is equivalent to 1 mg. of pure tocopherol acetate. In the biological assays the average amount of vitamin E is measured which will prevent resorption of the fetus in the female rat. Chemical assays are based on the ability of the vitamers to reduce ferric iron to ferrous iron, and measuring this reduction. Potentiometric titrations can also be used.

Vitamin E is essential for the normal course of pregnancy in rats and also for normal growth and the prevention of paralysis in rats. Its significance in human nutrition has not been established. Some authorities state that for the proper utilization of vitamin A, the to[illegible] in the diet. Others believe that the daily requirem[illegible] on the vitamin E content of the diet. [illegible] muscular disturbances is concerned, the many claims and counterclaims are at such variance as to make a critical analysis impossible.

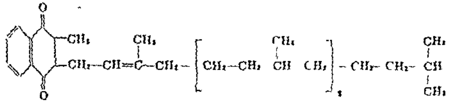
Dosage.—No definite dosage has been established, because its clinical use is largely empirical. Daily doses of 15 to 30 mg. of vitamin E given orally have been used in the treatment of habitual abortion.

Sources.—Wheat germ oil, cottonseed oil, green leafy vegetables, egg yolk and meat.

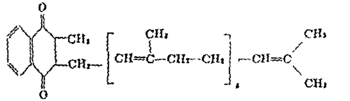
VITAMIN K

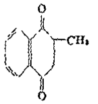
Vitamin K, the coagulation vitamin, occurs naturally in two forms, vitamin K_1 and vitamin K_2. Many synthetic compounds of related chemical constitution also have vitamin K activity.

Vitamin K_1 has the following structure:



Vitamin K_2 has the following structure





Menadione

[illegible] amin K_1 is a yellow crystal-
[illegible] of the synthetic vitamers,
[illegible] same vitamin activity as
[illegible] natural products, is odor-
[illegible] Menadione Sodium Bisulfite
(U. S. P [illegible] injection.
The p[illegible] ic menadione
Oxidatio[illegible] ds have been
establish[illegible] n K is based
upon its [illegible]

Vitamin K is said to be necessary for the formation of prothrombin in the liver. Since prothrombin is a constituent of the blood essential for normal clotting, vitamin K therefore plays an indirect rôle in that process A deficiency of prothrombin (hypoprothrombinemia) results in a prolongation of the clotting time

Deficiency of vitamin K is seldom due to dietary origin Since vitamin K is formed by microörganisms in the intestines, it seems reasonable to conclude that normal humans are largely independent of a dietary supply Inadequate absorption does occur in cases of obstruction, jaundice, diarrhea and during the excessive use of laxatives

The special use of vitamin K lies in its prevention of hemorrhagic disease of the new-born.

Definite daily requirements have not as yet been determined The therapeutic dose for the cure or prophylaxis of hypoprothrombinemia is 1 to 2 mg daily. Toxic effects have been noted in animals following the administration of large doses

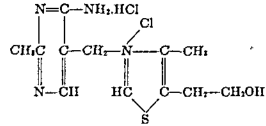
Sources.—In addition to the commercial sources mentioned above vitamin K occurs in green leafy materials such as spinach, kale, etc , in tomatoes and in vegetable oils.

THE VITAMIN B COMPLEX

The **Vitamin B Complex** includes a number of dietary essentials which are found in significant quantities in liver and yeast Originally it was not recognized that these natural extracts contained more than one vitamin but as research progressed several components were eventually isolated. In an early classification the "B Complex" was subdivided

into vitamins B_1 and B_2, the former being thermolabile and the latter thermostable. We now know the structure of at least nine and possibly ten substances recognized as members of this group. The vitamin status of some of them, although included in the group is not as yet clearly established. The members of the group have little in common from a chemical standpoint.

Thiamine Hydrochloride or Vitamin B_1 has the following structural formula:



It is in colorless, monoclinic needles, melting at 248° to 250° C., soluble in water, slightly soluble in alcohol, and insoluble in oil; it is relatively stable in dry form to heat and light; in aqueous solution the pH is about 3.5, and such solutions may be sterilized by heating for twenty minutes at 120° C

or as the cocarboxylase protein complex.

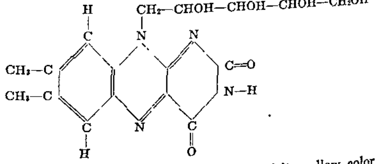
intermediate carbohydrate metabolism all body

defined.

Daily Requirement.—Adults, 1 2 to 2 mg.; infants, 0.4 to 0 8 mg.; children, 1 to 1.8 mg. The therapeutic dose is 5 to 50 mg.

Sources.—Enriched cereals, whole grain cereals, milk, legumes, meats. Special sources include yeast, liver concentrates and synthetic thiamine.

Riboflavin, Vitamin B_2, Vitamin G, or Lactoflavin has the following structure:



The substance was first identified in milk and because of its yellow color was known as "lactochrome" and later as "lactoflavin." It occurs naturally in the free form or in various chemical complexes with protein, phosphoric acid, adenine or nucleic acid.

Riboflavin is slightly soluble in water and in alcohol, and insoluble in lipoidal solvents. It crystallizes from absolute alcohol as yellow, needle-shaped crystals melting with decomposition at 282° C. It is stable to heat in dry form and in acid solution and rather stable to oxidation, but is unstable in alkaline solution and is very sensitive toward light. In solution it possesses an intense greenish yellow fluorescence. When exposed to light in acid solution the vitamin is changed to lumichrome, while when irradiated in alkaline solution a degradation split occurs yielding a new pigment, lumiflavin Neither lumichrome nor lumiflavin possesses physiological activity

One milligram of Riboflavin is equivalent to 400 Sherman-Bo[illegible]
The vitamin is assayed biologically by the rat-gro[illegible]
cal method is official for drugs and [illegible]
and a third method [illegible]

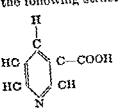
Riboflavin, follow[illegible]
to form an enzyme ca[illegible] animal cells and
enzyme." Apparentl[illegible] riboflavin functions, as the yellow
therefore must be su[illegible]
enzyme, in tissue oxida[illegible] Deficiency symptoms are characterized by cheilosis, glossitis and peeling of the skin. Ocular disturbances are characterized by itching, burning and a sensation of roughness of the eyes accompanied by mild photophobia.

DAILY REQUIREMENT.—Adults, 1 6 to 3 mg ; infants, 0 6 to 1 8 mg., children, 1.8 to 2 mg. The therapeutic dose is 3 to 15 mg

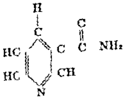
SOURCES.—Milk, egg yolk, liver, meats, green leafy vegetables and bread

Niacin or Nicotinic Acid, and Niacinamide or Nicotinamide.—The names Niacin and Niacinamide have been recommended by The Food and Nutrition Board of the National Research Council because these names do not have the phonetic similarity to nicotine as do the older names

They have the following structural formulas



Niacin



Niacinamide

These substances have been known since 1867 and their occurrence in animal tissues was recognized in 1912 No dietary importance was attached to them, however, until 1937, when it was reported that liver, a source rich in niacin, cured "black tongue" in dogs, which had long been considered to have a counterpart in the human disease known as pellagra

Niacin occurs as colorless, odorless needles or as a crystalline powder It is soluble in water and alcohol but is insoluble in lipoidal solvents It is quite stable both in dry form and in solution The amide, also a colorless, crystalline powder, is slightly hygroscopic, and has a slightly bitter taste It melts at about 122° C. and is more soluble in water and alcohol than the acid. It is quite stable in dry form and in solution Prolonged exposure to light should be avoided.

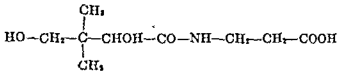
In nature, the vitamin is found as the free acid or its amide, chemically bound in a number of enzyme systems Niacinamide is the functional group in co-enzymes I and II, diphosphopyridine nucleotide and triphosphopyridine nucleotide respectively. These compounds play an important rôle in tissue respiration, carbohydrate metabolism and in fermentations by transporting hydrogen

Potencies of niacin are expressed in terms of milligrams rather than in units. The substance is assayed biologically by the black-tongue curative and the chick-growth methods. The microbiological method is official for drugs and foods. A chemical colorimetric method using cyanogen bromide and various amines has also been proposed. While most of the symptoms of pellagra are

4 mg. T niacin is 500 mg. per day.

Sourc reals and nuts.

Panto the *factor in the vitamin B complex necessary for the proper growth of rats.* It is also known as the "chick anti-dermatitis factor." The substance has the following formula:



It is dextrorotatory and is usually marketed as the calcium salt, **Calcium Pantothenate Dextrorotatory.**

The *acid itself* is a viscous oily liquid, soluble in water and some organic *solvents* but *insoluble* in benzene and chloroform. Pantothenic acid is unstable *toward acids, alkalis* and *prolonged heating when in aqueous solution.* The calcium salt is stable toward alkalis, acids, ferric salts and

The potency

It is assayed biologically by the

methods, employing either *Lactobacillus casei*

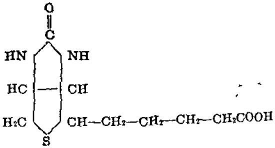
date no chemical test for this substance has been found.

Although pantothenic acid is found in most living tissue its definite rôle is unknown and no definite pantothenic acid deficiency has been demonstrated in man.

Therapeutic dose, 1 to 100 mg.

ilk, cereals, legumes and nuts.

owth, or the anti-egg-white injury factor, has the following structural formula:

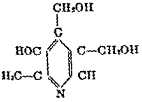


Free biotin is water and alcohol soluble but is relatively insoluble in ether, chloroform and petroleum ether. The substance is heat stable and *does not* decompose when heated with acids or alkalis. The pure vitamin melts at 230° to 232° C., while its methyl ester melts at 166° to 167° C. Biotin is active in both animals and microorganisms, and the methyl ester is *active* for animals but not for all microorganisms. Amounts of biotin are expressed in milligrams and microbiological methods have supplanted the rat- or chick-curative method.

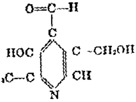
Biotin deficiency symptoms have not as yet been definitely established. The vitamin, however, is claimed to be necessary for the *maintenance* of health. Some of the symptoms due to a deficiency of biotin are said to be *seborrheic* dermatitis, pallor of the skin, mental depression and muscular pains. *Avidin,* a raw-egg-white protein induces biotin deficiency by forming a *non-absorbable* avidin-biotin complex.

DAILY REQUIREMENT.—Unknown. Therapeutic dose, parenteral, 0 15 to 0 3 mg. (150 to 300 micrograms) daily.
SOURCES.—Egg yolk, liver, kidney, yeast, grains and milk

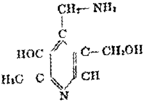
Pyridoxine or Vitamin B_6 consists of a group in which pyridoxine is one of three members. The three forms known at the present time are as follows:



Pyridoxine



Pyridoxal



Pyridoxamine

The three forms are about equally active for rats but not so for microorganisms Pyridoxine melts at 204° to 205° C The substance is soluble in water, alcohol and acetone and slightly soluble in other organic solvents It is stable toward heat, concentrated acid and alkali, but is destroyed by light Potencies of pyridoxine are expressed in milligrams or micrograms Biological methods of assay include the rat growth and acrodynia cure test Microbiological procedures use *Streptococcus Carlsbergensis*, *Lactobacillus casei*, *Streptococcus fæcalis* Some chemical methods showing promise recently have been published

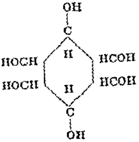
Pyridoxine appears to be related to the metabolism of fats and amino acids Its exact biological function is, however, not fully understood Rats deprived of pyridoxine develop a symmetrical dermatitis (acrodynia) and fail to grow. Dogs and other animals develop microcytic anemia and exhibit a degeneration of striated and cardiac muscles

Since no definite vitamin B_6 deficiency syndrome has been recognized in man, no diagnosis based on clinical sym[illegible] able It has been pointed out, however, that pyrid[illegible] many other deficiencies of the B complex. [illegible] B complex deficiency to recover complete [illegible] and nicotinic acid were administered has been n[illegible] ients continued to complain of extreme nervousness, irritability, insomnia, abdominal pain and difficulty in walking Parenteral administration of pyridoxine hydrochloride in such patients is claimed to have produced dramatic relief.

DAILY REQUIREMENT.—Unknown Therapeutic dose, 25 to 200 mg , orally or parenterally.
SOURCES.—Meats, seafoods, cereals, legumes and yeast.

OTHER WATER-SOLUBLE FACTORS FOUND IN LIVER AND YEAST, WHOSE VITAMIN STATUS HAS NOT BEEN CLEARLY ESTABLISHED

Inositol, known to chemists for a long time, has the following formula



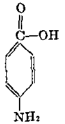
Of th... ...active. This ...ccurs in the ... Inositol is soluble in water and insoluble in petroleum ether and in absolute alcohol. It is stable toward heat, strong acids and alkalis. The anhydrous form melts at 225° to 226° C. ... in units. Microbic ... *sitophila* have been ...

The nutritional s... it appears to prevent alopecia, to have lipotropic activity and influence gastric motility. Conflicting observations indicate that inositol is not a dietary essential or that the substance may be involved in intestinal flora activity. Because no specific deficiency syndromes in man have been attributed to inositol, its exact rôle in human metabolism is unknown.

Daily Requirement.—Unknown. No therapeutic claims for inositol have been recognized.

Sources.—Cereals, citrus fruits, certain meats, milk and yeast.

Para-aminobenzoic Acid has long been known as a synthetic organic chemical compound, and has the following formula:



It has only recently been recognized to be a component of the B-Complex. The substance occ... ...ated form. It is soluble in bc... The colorless cryst... oxidizing agents. ... acid. Both chemi... assay of this comp... achromotrichia in rats and failure of growth in chicks. It is active in neutralizing the anti-bacteriostatic effect of some sulfa drugs. Therapeutic claims for man have not been recognized.

Daily Requirement.—Unknown. Therapeutic claims for man have not been recognized, though a daily dose of 200 mg. is given.

Sources.—Meats and vegetables.

Choline as a component lecithin and a phospholipid has been known for many years. It has the following formula:

$$(CH_3)_3{-}\underset{\displaystyle OH}{\underset{|}{N}}{-}CH_2{-}CH_2{-}CH$$

Recently ... ...ed it as a member of the B-Complex. Choline is ... ...e chloride are soluble in w... ...and petroleum ether. They ... ...kaline solution. They are extremely hygroscopic. Potencies are expressed in milligrams of choline. Colorimetric as well as microbiological procedures have been used as methods of assay.

Choline affects the fat transport and indirectly carbohydrate metabolism. Deficiency of choline leads to hemorrhagic kidney degeneration. It is one of the

ctors in the pancreas which prevents development of fatty livers in depan-eatized animals. It has been reported that choline may be useful in the treat-ent of human liver cirrhosis, however, definite therapeutic claims have not een reported.

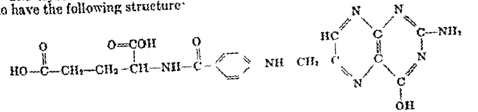
DAILY REQUIREMENT.—Unknown Therapeutic dose, undetermined

SOURCES.—Egg yolk, heart, liver, sweetbreads, milk, fish, root vegetables, uits and grains.

DIETARY FACTORS CONCERNED WITH NUTRITIONAL ANEMIAS

A number of water-soluble acidic materials found in yeast, liver and green eaves have been isolated and shown to have activity in preventing anemia in hicks and other animals, and in promoting growth in chicks and in rats as vell as in certain microorganisms such as *Lactobacillus casei*, *Streptococcus actis*, and *Streptococcus fecalis* Various names have been applied to these actors such as **Vitamin B_c, L. casei factor, Vitamin M** or **"folic acid,"** and **ptero-glutamic acid.**

The crystalline *L. casei* factor of liver has been synthesized and is reported to have the following structure·



It is a yellow crystalline powder

It now appears that vitamin B_c and crystalline *L casei* factor as isolated from liver are identical A crystalline precursor of vitamin B_c has been isolated from yeast and has tentatively been named vitamin B_c Conjugate The latter substance can be converted into vitamin B_c by enzymatic treatment

The term vitamin M refers to a growth and anti-anemia factor for monkeys Its nature has not been established but it is believed to be vitamin B_c because of its biological properties The term "folic acid" has been used by different investigators to designate any one of a number of these biologically similar factors The potency is expressed in micrograms of folic acid While micro-biological methods have been devised for the determination of "folic acid" the anti-anemia potency must be measured by using chicks or rats

Deficiency of this vitamin causes retardation of growth and macrocytic anemia in the chick and rat The synthetic material has recently been claimed to be of value in macrocytic anemia, including pernicious anemia in the human.

DAILY REQUIREMENT —Unknown

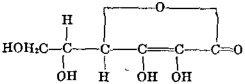
SOURCES —Yeast, liver, grass, and green leafy vegetables

In addition to the known vitamins which have been discussed, there are a number of compounds which at the present time are thought to be vitamins. As far as their importance in human nutrition is concerned we can only speculate and until further investigations are carried out and their value more definitely established, mention of them here is omitted

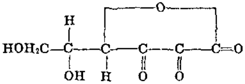
VITAMIN C

Ascorbic Acid or Vitamin C (U. S. P. and N. N. R) and **Sodium Ascor-bate Injection** are the official forms of the antiscorbutic vitamin found naturally in several forms, the reduced form (ascorbic acid), the oxidized form (dehydroascorbic acid) and as ascorbinogen (the protein complex).

The formula for the reduced form is as follows:



while the oxidized form has the following structure:



Ascorbic Acid is an optically-active compound, but only the levo-form is biologically active. It is an odorless, white, crystalline substance which slowly darkens upon exposure to light. It melts at 190° to 192° C., and is soluble in water, alcohol, propylene glycol and glycerin, but is insoluble in ether and benzene. Dry ascorbic acid is fairly stable but aqueous solutions are rapidly decomposed when in contact with air. Ascorbic acid is a relatively strong reduc- ... The latter can be ... lkalis accelerate ... ie least stable of ... when planning diets.

The potency is expressed in milligrams of ascorbic acid Although bioassay methods based on the curative or preventative effect of ascorbic acid continue to be used, they are gradually being displaced by chemical methods using the 2,6, dichlorophenolindophenol acid and in some cases, the 2,4,dinitrophenylhydrazine procedures.

Vitamin C appears to be essential for the proper formation as well as the maintenance of intercellular material in tissues, especially of bones and teeth It prevents and cures s ... to be of value in increasing resistance ... hed to be of clinical importance in ... c acid is an important factor in cellular oxidation and reduction processes.

Daily Requirement —Adults, 30 to 75 mg.; children, 30 to 100 mg.; infants, 30 mg Average dose, 50 mg.

Sources —Fresh fruits, potatoes, green leafy vegetables and seafoods.

Citrin or Vitamin P are terms used to designate a dietary factor, other than ascorbic acid, n... proper capillary resistance. At present vitamin ... ure form. Several flavone glycosides including ... been found to have vitamin P activity.

Tentative methods of assay are based upon measurements of capillary fragility in test animals. Various fruit extracts have been used as standards Citrin restores permeable and fragile capillaries to their normal state. It appears to be of value in the treatment of conditions of the skin (nutritional purpurea and purpurea of measles) in man. Its rôle as a dietary essential has as yet not been definitely established.

Sources.—Hungarian red pepper, citrus fruits and black currants. So far no animal sources have been demonstrated.

VITAMIN PREPARATIONS

Vitamins A and D:

Oleovitamin A, Natural Vitamin A in Oil (U. S. P. 1940 to date) is either fish liver oil, or fish liver oil diluted with edible vegetable oil, or

a solution of vitamin A concentrate from natural sources (animal) in fish liver oil or edible oil. Oleovitamin A contains in each gm. not less than 50,000 and not more than 65,000 U. S. P. Units of vitamin A, and not more than 1000 U. S. P. Units of vitamin D. Average daily dose 0.1 cc. Preparation: Oleovitamin A Capsules

Oleovitamin A and D (U. S. P. 1940 to date) is either fish liver oil, or fish liver oil diluted with an edible vegetable oil, or a solution of vitamin A and D concentrates in fish liver oil or in an edible vegetable oil. The vitamin A shall be obtained from natural (animal) sources and the vitamin D may be obtained from natural (animal) sources or may be synthetic Oleovitamin D. Oleovitamin A and D contains in each gram not less than 850 and not more than 1100 U. S. P. Units of vitamin A, and not less than 85 and not more than 110 U. S. P. Units of vitamin D. Average daily dose, 8 cc.

Concentrated Oleovitamin A and D (U. S. P. 1940 to date) is either fish liver oil, or fish liver oil diluted with an edible vegetable oil, or a solution of vitamin A and D concentrates in fish liver oil or in an edible vegetable oil. The vitamin A is obtained from natural (animal) sources and the vitamin D may be from natural (animal) sources or may be synthetic Oleovitamin D. Concentrated Oleovitamin A and D contains in each gram not less than 50,000 and not more than 65,000 U. S. P. Units of vitamin A, and not less than 10,000 and not more than 13,000 U. S. P. Units of vitamin D. Average daily dose, 0.1 cc. Preparation: Concentrated Oleovitamin A and D Capsules

Synthetic Oleovitamin D, Viosterol in Oil (applying only to Activated Ergosterol in Oil) (U. S. P. 1936 to date) is a solution of activated ergosterol, or activated 7-dehydrocholesterol, in an edible vegetable oil. Synthetic Oleovitamin D contains in each gram not less than 10,000 U. S. P. Units of vitamin D. Average daily prophylactic dose, 0.1 cc.

Cod Liver Oil (U. S. P. 1851 to date) (see page 662) contains not less than 850 U. S. P. Units of vitamin A and not less than 85 U. S. P. Units of vitamin D per gram. Average dose, 8 cc. Preparation: Cod Liver Oil Emulsion.

Non-Destearinated Cod Liver Oil (U. S. P. 1936 to date) (see page 663) has the same requirements as for Cod Liver Oil.

Halibut Liver Oil (U. S. P. 1942 to date) (see page 663) contains in each gram not less than 60,000 U. S. P. Units of vitamin A and not less than 600 U. S. P. Units of vitamin D. Average daily dose, 0.1 cc. Preparation: Halibut Liver Oil Capsules

Carotene in Oil and Carotene With Vitamin D Concentrate in Oil are non-official preparations in which the carotene and vitamin D are dissolved in cottonseed oil. Both preparations have a vitamin A potency of not less than 7500 U. S. P. Units per gram, and the latter has a vitamin D potency of not less than 1000 U. S. P. Units per gram.

Vitamin D_2 or Drisdol (non-official) is prepared by ultra-violet irradiation of ergosterol and contains not less than 40 U. S. P. Units of vitamin D per microgram.

Burbot Liver Oil (non-official) (see page 664) contains not less than 4480 *U. S. P. Units of vitamin A* and not less than 640 U. S. P. Units of vitamin D per gram.

Percomorph Liver Oil (non-official) (see page 664) contains not less than 60,000 U. S. P. Units of vitamin A and not less than 8500 U. S. P. Units of vitamin D per gram.

Shark Liver Oil (non-official) (see page 664) contains not less than 16,500 U. S. P. Units of vitamin A and not less than 40 U. S. P. Units of vitamin D per gram.

VITAMIN K:

Menadione, 2-Methyl-Naphthoquinine, Menaphthene or Menaphthone (U. S. P. 1942 to date). Average dose, 1 mg. Preparation: Menadione Tablets.

Menadione Sodium Bisulfite or Menadione Bisulfite (U. S. P. 1947 to date) contains not less than 49 per cent of menadione. Average parenteral dose, 2 mg. Preparation: Menadione Sodium Bisulfite Injection.

VITAMIN B COMPLEX:

Thiamine Hydrochloride, Vitamin B_1, Vitamin B_1 Hydrochloride or Aneurine Hydrochloride (U. S. P. 1940 to date) contains not less than 98 per cent of $C_{12}H_{17}ClN_4OS.HCl$. Average dose, 5 mg. *Preparations:* Thiamine Hydrochloride Injection, Thiamine Hydrochloride Tablets.

Rice Polishings, Rice Bran, Tikitiki (U. S. P. 1942 to date) consists of the fine flaky pericarp and spermoderm fragments, the embryo, aleurone layer, and outer adhering cells of the starchy endosperm of the grain of *Oryza sativa* Linné.

Rice Polishings Extract (U. S. P. 1942 to date) contains in each cubic centimeter not less than 20 U. S. P. Units of vitamin B_1, and represents approximately 14.5 gm. of rice polishings. Average dose, 8 cc.

Riboflavin, Lactoflavin, Vitamin B_2 or Vitamin G (U. S. P. 1942 to date), when dried at 100° for three hours, contains not less than 98 per cent of $C_{17}H_{20}N_4O_6$. Average dose, 5 mg. Preparations: Riboflavin Injection and Riboflavin Tablets.

Nicotinic Acid or Niacin (U. S. P. 1940 to date), when dried over sulfuric acid for three hours, contains not less than 99.5 per cent of $C_6H_5O_2N$. Average dose, 25 mg. Preparations: Nicotinic Acid Tablets.

Nicotinamide, Nicotinic Acid Amide or Niacinamide (U. S. P. 1942 to date) when dried over sulfuric acid for four hours, contains not less than 98.5 per cent of $C_6H_6N_2O$. Average dose, 25 mg. Preparations: Nicotinamide Injection, Nicotinamide Tablets.

Pyridoxine or Vitamin D_6 (non-official). Average dose, 5 mg.

Dried Yeast or Dry Yeast (U. S. P. 1944 to date) consists of the dried cells of any suitable strain of *Saccharomyces cerevisiæ* Meyen. Dried Yeast contains not less than 40 per cent of protein and, in each gram, the equivalent of not less than 0.12 mg. of thiamine hydrochloride, 0.04 mg. of riboflavin, and 0.25 mg. of nicotinic acid. Average dose, to be determined by the physician. Preparation: Dried Yeast Tablets.

Triasyn B Capsules and Triasyn Tablets (U. S. P. 1947 to date) contain in each capsule or tablet not less than 2 mg. of thiamine hydrochloride, 3 mg. of riboflavin, and 20 mg. of nicotinamide

Hexavitamin Capsules and Tablets (U. S. P 1947 to date) contain not less than 5000 U. S. P. Units of vitamin A from natural (animal) sources, 400 U. S. P. Units of vitamin D from natural (animal) sources or as activated ergosterol or activated 7-dehydrocholesterol, 75 mg. of ascorbic acid, 2 mg. of thiamin hydrochloride, 3 mg. of riboflavin, and 20 mg. of nicotinamide per capsule or tablet.

VITAMIN C:

Ascorbic Acid or Vitamin C (U. S P 1940 to date), when dried in a vacuum desiccator over sulfuric acid for three hours, contains not less than 99 per cent of $C_6H_8O_6$. Average dose, 50 mg. Preparation · Ascorbic Acid Tablets.

Sodium Ascorbate Injection (U. S. P 1947 to date) is a sterile solution of sodium ascorbate in water for injection Average dose of ascorbic acid, 0.1 gm.

Manufact[illegible] dosage form [illegible]

Or[illegible] U. S P 1820 to 1905), which is [illegible] *Acipenser huso* and other specie[illegible] [illegible]red and scraped to remove the o[illegible] layer. The inner layer is dried, usually stretched into sheets on pegs. Its principal constituent is gelatin and it has been used as an emollient and a protective

American Isinglass consists of the sounds of the hake (*Gadus merluccius*) or the weakfish (*Otolithus regalis*).

CLASS REPTILIA, ORDER OPHIDIA, FAMILY CROTALIDÆ

Reptiles comprise one of six classes of vertebrates, being placed above the amphibians but below the birds They begin the series of higher vertebrates which never breathe with gills The class includes five orders comprising turtles, lizards, snakes, crocodiles and alligators. The order *Ophidia* includes the snakes, of which the family of pit vipers (*Crotalidæ*) is of special interest. To this family belong the rattlesnake, the water moccasin and the copperhead, all of which have fangs connected with special poison glands, by means of which a toxin is injected into the circulation of any animal they may bite. To counteract this poison, **North American Antivenin (Nearctic Crotalideæ Antivenin)** has been prepared. (See Antivenins, page 76.)

CLASS AVES, FAMILY PHASIANIDÆ

The *Aves* or birds are warm-blooded, oviparous vertebrates differing from other vertebrates in possessing feathers. The forelegs are modified into wings.

The *Phasianidæ* include chickens, turkeys, partridges, and other fowl-like birds with usually a terrestrial but sometimes a tree habit.

They have short, rounded wings and stout legs terminating in sharp-clawed toes especially adapted to scratching.

Egg, Hen's Egg or Fresh Egg (*U. S. P. 1851 to 1882; N. F. 1916 to 1947; in culture media N. F. 1936 to date*) is the recently laid egg of *Gallus domesticus* Temminck. *Ovum* is Latin for egg; *Gallus* is the Latin name of the hen, and *domesticus* is Latin, meaning domesticated. Chickens are raised in the United States and practically all other temperate and tropical countries for their flesh and for the production of eggs. Those fowls having Mediterranean ancestry, of which the Leghorns are the best known variety, are particularly valuable as egg producers.

DESCRIPTION.—Hens' eggs are
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of the total weight of the egg, consists of about 85 per cent of water, 12 per cent of protein matter and 2.5 per cent of ovamucoid (a mucin-like substance), with traces of fats and mineral salts.

The egg yolk, comprising about 32 per cent of the total weight of the egg, consists of about 52 per cent water, 20 to 30 per cent of fat, about 16 per cent of a protein known as vitellin, about 1.5 per cent of the protein nuclein, which is rich in phosphorus, about 7 per cent of lecithin, about 0.5 per cent of cholesterin and small quantities of cerebrin (found in brain and nerve tissue) and mineral salts. Vitamins A, B and C are also present in egg yolk. Vitamin B_2 is present in egg-white.

USES.—Egg shell has been used as an antacid. Egg white is a clarifying agent and as such has been employed domestically for a long time in coffee making. It is also employed as an antidote for corrosive poisons where it acts both by combining with the corrosive agent and by protecting the mucous tissues mechanically. suitable for preparations eservatives be added.

Eggs have a considerable food value and are recommended as a source of the constituents of brain and nerve tissue. They are also high in protein and vitamins.

ALLIED DRUGS.—**Fresh Egg Yolk or Vitellus** (U. S. P. 1882 to 1905, N. F. 1916 to 1947; in culture media, N. F. 1936 to date); **Fresh Egg Albumin** (N. F. 1916 to 1936; in culture media, N. F. 1936 to date; as a reagent, U. S. P. 1894 to date; N. F. 1936 to date); **Egg Shell or Testa Ovi**; **Albumin Tannate or Albutannin** (U. S. P.
and tannic acid whic
(10) and tannic acid (
Albumin tannate is
stomach and in the i
acid. Average dose, 2 gm.

CLASS MAMMALIA, ORDER CETACEA, FAMILY PHYSETERIDÆ

This class is characterized by the females having milk-secreting mammæ to nourish their young. The body is generally clothed with

air, respiration takes place by means of lungs, the brain is well developed and the heart is divided into two auricles and two ventricles. The general structure is largely dependent upon habits. To this class belong all the warm-blooded quadrupeds, bats, seals, whales, apes and man.

The *Cetacea* or whales have the pelvis and posterior limbs atrophied and possess a fish-like body specialized for swimming and ending in a horizontal tail or fluke. The anterior limbs are modified into fins or flippers. The body possesses little or no hair. It is thought by some that whales are the descendants of the large prehistoric animals which once roamed the earth, and which escaped extinction by adapting themselves to life in the sea. This order includes the largest animals living on the face of the earth today. The order is usually divided into the toothless or baleen whales which yield whalebone and oil and the toothed whales, which include the sperm whale yielding spermaceti, and the dolphins and porpoises.

SPERMACETI

Spermaceti or Cetaceum (U. S. P. 1820 to date) is a waxy substance obtained from the head of the sperm whale, *Physeter macrocephalus* Linné. The generic name *Physeter* is from the Greek, meaning a blowpipe, and refers to the spouting of the whale; *macrocephalus* is from the Greek, meaning a large head.

The sperm whale is the only representative of its genus. It is widely distributed in schools in tropical and subtropical seas, principally the Pacific and Indian oceans. This whale often attains a length of 20 meters. It has an enormous head, comprising about one-third of its body and up to 9 meters in circumference. Near the snout is a blowhole through which the sperm whale ejects water to a considerable height. Its lower jaw is provided with large conical teeth, while the upper jaw has no functional teeth. In front of the cranium is a large cavity which contains an oily fluid. After killing the animal, which is usually accomplished with torpedo harpoons which explode upon striking the animal, the cranial cavity is opened and the oily liquid transferred to barrels, a single whale yielding from 10 to 12 barrels of oil. On cooling, about 10 to 12 per cent of spermaceti separates out, which is removed by straining, and purified by compression and washing with weak, boiling alkali. The purified spermaceti is then allowed to cool and congeals into cakes.

DESCRIPTION.—A white, somewhat translucent, slightly unctuous mass having a crystalline fracture, and a pearly luster. It has a very faint odor, and a bland, mild taste. Consult the U. S. *Pharmacopœia for standards and tests*.

CONSTITUENTS.—Spermaceti consists almost entirely of cetyl palmitate, $C_{15}H_{31}COOC_{16}H_{33}$.

USES.—Spermaceti is an emollient and is used as a base for cerates and ointments.

ALLIED PRODUCTS.—**Ambergris** is a pathological product found in the intestine of the sperm whales or cast by them into the sea. It occurs in irregular grayish or brownish masses up to 75 kg. in weight. It contains a substance known as

ambrein. Ambergris is high-priced and is used principally in perfumery *as a* [illegible]

have also been invented to replace **whalebone**, so that the one-time large and flourishing whaling industry is now nearly extinct.

UNGUICULATA, ORDER CARNIVORA, FAMILY VIVERRIDÆ

The *Unguiculata* are the clawed mammals; the *Carnivora*, the flesh-eating animals with large projecting canine teeth; and the *Viverridæ* are the civet-cats and mongooses. The terrestrial *carnivora also include* dogs, foxes, raccoons, skunks, hyenas, cats, lions, etc.

Civetta or Civet *is an unctuous secretion contained in a special pouch in both the* male and female Civets, *Viverra civetta* and *V. zibetha*. The former is indigenous to Africa and the latter to southern Asia. These small cat-like carnivorous animals have short legs, a curly tail, a long body and a sharp snout. They are sometimes kept in captivity, the secretion being removed by means of a small spoon, a few cubic centimeters being obtained from each animal at intervals of a few days. The secretion is dried and at first is of a yellowish color, becoming dark brown; it has a strong musk-like odor, which becomes pleasant on dilution and is used both alone and for fixing other odors. The American civet-cat of Mexico is not a true civet, but is related to the raccoon and is similar in its haunts and habits to the latter.

UNGUICULATA, ORDER *RODENTIA, FAMILY CASTORIDÆ*

The rodents, or gnawing animals, include the hares, squirrels, gophers, mice, rats, guinea-pigs and beavers; the latter grouped into the family *Castoridæ*.

Castoreum or Castor (U. S. P. 1820 to 1882) consists of the dried preputial follicles of the beaver, *Castor fiber*, collected in Canada, the United States and Siberia. It contains a musk-like secretion used as a fixative in perfumery.

ORDER UNGULATA, FAMILY CERVIDÆ, SUBFAMILY MOSCHIDÆ

This is an order of mammals which are terrestrial and largely herbivorous. They have more or less hair and are characterized by having solid, tough, horny hoofs. The canine teeth are very small but the molars and premolars have broad crowns and are well adapted to chewing. The order is divided into four groups: (1) the *Artiodactyla* (with an even number of toes) like the hog, peccary, hippopotamus, camel, sheep, deer and cattle; (2) the *Perissodactyla* (with an odd number of toes) like the tapir, rhinoceros and horse; (3) the *Hyracoidea; and* (4) the *Proboscidea* or elephants. The sub-order *Artiodactyla* is sometimes divided into ruminants (those that chew the cud) and non-ruminants. The horse of the genus *Equus* (Fam. *Equidæ*) yields nothing *directly to medicine, but is employed in the* production of certain antibodies such as the antitoxins and antivenins, described on pages 74 to 76.

The family *Cervidæ* includes the deer, the principal characteristic of which are the antlers, present usually only in the male. *Some* authors

nsider the musk-deer as a sub-family, while others classify it as a stinct family.

The *Moschidæ* includes the small hornless deer having a short tail. he canine teeth are well developed and in the male project from the pper jaw. The musk deer is important as the source of musk which, hile not official, is nevertheless an important and valuable article.

Moschus or Musk (U. S. P. 1820 to 1926) is the dried secretion from a special llicle of *Moschus moschiferu*
the northern provinces of
blelands of the Balkan Se
nd is located on the abdomen between the umbilicus and the preputial follicle.

ith grayish brown hairs, which
ice The secretion in the fresh
the form of irregular granules
or brownish black color, being
enetrating and persistent odor
nd an aromatic, bitterish taste.

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Musk contains from 0.5 to 2 per cent of a colorless, viscid volatile oil, con-

etected.

produces a very
rarely obtained
se is restricted

FAMILY BOVIDÆ

This is a family of ruminating mammals possessing hollow, unbranched horns. To this family belong the sheep, antelope, ox, buffalo and bison Two animals, the sheep (*Ovis aries*) and the ox (*Bos taurus*) are of interest as sources of drugs.

The sheep was probably the first animal domesticated by man. Its wool constitutes one of our most important textile fibers and supplies a large part of the clothing of man. Leather made from the skin is used

in bookbinding and for making gloves. The intestines are used as sausage casings and also supply catgut, used for ligatures and as strings for musical instruments. The meat of the sheep known as mutton is an important article of food. Among the drugs yielded by the sheep are the *fat of the wool*, known as *wool fat*, the *abdominal fat*, known as *suet*, and many glandular products. Sheep are widely bred in the temperate zones, the United States having approximately 50,000,000.

The term cattle is applied to domesticated bovine animals of which there are two principal species, *Bos taurus*, including the European cattle, and *Bos indicus* the humped cattle of India and Africa, the latter known as Zebu. American cattle are descendants of cattle imported largely from Great Britain. Our cattle have been extensively bred with two objects in view, that of producing flesh (*Beef cattle*) and that of increasing lactation (Dairy cattle). Most of the pharmaceutical products yielded by cattle are collected at the time of slaughter, purified and preserved according to their nature. Among these products are oxgall, and glandular substances. *Cattle, together with sheep and hogs,* are the source of such important enzymes as pepsin and pancreatin and the extensively used endocrine products. The student is also referred to the preparation of smallpox vaccine (see page 67), which is prepared upon living calves.

PREPARED SUET

Prepared Suet or Mutton Suet (U. S. P. 1820 to 1947; N. F. 1947 to date) is the internal fat of the abdomen of the sheep, *Ovis aries* Linné, purified by melting and straining. The generic name *Ovis* is the Latin word for sheep and *aries* is Latin for ram. The internal fat of the abdomen removed during slaughtering is comminuted, mixed with water, heated to about 65° C. (when the melted suet rises to the top), separated, strained and allowed to cool and congeal.

Description.—Prepared suet is a white, solid fat, having, when fresh, a slight, characteristic odor and bland taste. It becomes rancid on prolonged exposure to air and must not then be used. Consult the National *Formulary* for its solubility.

Constituents.—Prepared suet contains from 70 to 80 per cent of stearin and palmitin and from 20 to 30 per cent of olein.

Standards and Tests.—Prepared suet melts between 45° and 50° C. and congeals between 37° and 40° C.; its saponification value is *not less than* 193 and not more than 200; its iodine value is not less than 33 and not more than 48, and the fatty acids in 10 gm. require not more than 6 cc. of tenth-normal sodium hydroxide for neutralization.

Uses.—Prepared suet is an emollient. It enters into certain *ointments*, where it is stiffer than lard.

Stearic Acid (U. S. P. 1894 to date) is a mixture of solid acids obtained from fats, and consists chiefly of palmitic acid, $CH_3(CH_2)_{14}COOH$, and stearic acid, $CH_3(CH_2)_{16}COOH$.

... from mutton or beef tallow. *The fat is saponi-* ... fatty acids pressed to remove ... for the characters and tests

of stearic acid. It is used in the manufacture of glycerin suppositories (as sodium stearate) and for certain skin affections (as zinc stearate).

Oleic Acid (U. S. P. 1882 to date) is a liquid acid obtained from tallow and other fats, consisting chiefly of $CH_3(CH_2)_7CH{:}CH(CH_2)_7COOH$.

As mentioned above, oleic acid is obtained as a by-product in the manufacture of stearic acid. It is also obtained from certain fixed oils, notably almond oil. Consult the Pharmacopœia for characters and tests. Oleic acid is largely used in the preparation of oleates.

WOOL FAT

Wool Fat or Anhydrous Lanolin (*U. S. P. 1905 to date*) is the purified, fat-like substance from the wool of the sheep, *Ovis aries* Linné. Wool contains up to 50 per cent of a fat-like or waxy substance known as suint which is removed by washing the wool with benzin or other cheap solvent or by treatment with soap solution. It is then collected, strained, purified, bleached and finally dehydrated. The processes for these steps are either secrets or covered by patents.

[illegible] as, unctuous mass, hav- [illegible] e in water, but can be [illegible] water It is sparingly [illegible] freely soluble in ether and in chloroform.

[illegible]

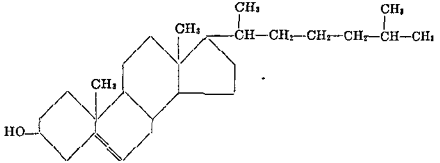
[illegible] ous [illegible] base for creams and ointments It [illegible] than any other known fat and is [illegible] nd other remedies which are to be [illegible]

Hydrous Wool Fat or Lanolin (U S. P. 1894 to date) is wool fat containing not less than 25 per cent and not more than 30 per cent of water. Consult the U. S. Pharmacopœia for its characters and tests. It is used as a vehicle for the external administration of remedies locally or by inunction.

STEROLS

The sterols comprise a large group of substances occurring in plants and animals. They are usually associated with fats and are found in the unsaponifiable portions of those fats. They differ little in structure all having the cyclopentanophenanthrene nucleus to which a hydroxyl group is attached at position 3, methyl groups at 10 and 13 and a side chain at 17. Double linkages may be present in the side chain, in the

cyclic system, or in both. Cholesterol, the most common of the sterols has the following formula:



Many therapeutic agents of rather widely different therapeutic activity are, or contain, sterols. Among these may be mentioned:

Ergosterol, which when irradiated becomes Calciferol or vitamin D_2, and also vitamin D_3 which is 7-dehydrocholesterol.

The Bile Acids, including taurocholic, glycocholic and cholic.

The Estrogens, including Estrone, Estriol and Estradiol.

The Androgens, including Testosterone and Androsterone. (These are sterones in which an —OH group becomes an O.)

The Adrenal Cortex Hormones. (see page 708).

The Digitalis Aglycones, such as Digitoxigenin obtained upon the hydrolysis of Digitoxin.

Cholesterol or Cholesterin (U. S. P. 1947 to date, N. F., as a reference standard. 1936 to date) comprises the larger part of Lanolin and is found in many other drugs.

The Saponins.—Some of the aglycones of the saponins have been shown to possess the cyclopentanophenanthrene nucleus.

OX BILE

Ox Bile or Oxgall (U. S. P. 1882 to 1947; N. F. as a reagent, 1942 to date; U. S. P. as purified oxgall, 1882 to 1916; as inspissated oxgall 1882 to 1894) is the fresh bile of *Bos taurus* Linné. The generic name *Bos* is from the Latin *bovis* or the Greek *bous* meaning ox; *taurus* (or Greek *tauros*) means a bull. Bile is a natural secretion of the liver which during life passes into the intestinal tract where it aids in the digestive processes by emulsifying fats, promoting peristalsis and absorption, and preventing putrefactive changes.

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A brownish green or ty

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contains from 80 to 90 per cent of water and from

ly of the sodium salts of

"bile salts." Glycocholic

urocholic acid hydrolyzes

e bile pigments bilirubin

oline, fat, albumin, mucin

and urea.

Tests.—Of particular interest is the official test (Pettenkoffer's reaction) which is carried out as follows: 2 drops of ox bile are mixed with 10 cc. of water and a drop of freshly prepared solution of 1 part of sucrose in 4 parts of water. Sulfuric acid is cautiously added until the precipitate first formed is redissolved the mixture gradually acquires a brownish red color, changing successively to carmine, purple and violet. The violet color is due to the reaction between cholic acid, formed from the hydrolysis of the bile acids, and furfuraldehyde formed by the action of the acid on the sucrose.

Ox Bile Extract or Powdered Oxgall Extract (U. S. P. 1916 to date) is prepared by partial evaporation of fresh ox bile, precipitation of the mucus and albuminous matter with alcohol, filtering, washing and evaporating the combined filtrates to dryness at a temperature not exceeding 80° C. The resulting extract is powdered and sufficient starch added so that 1 gm. of the extract represents 8 gm. of ox bile.

Uses and Dose.—Ox bile is a cholagogue, a laxative and an intestinal antiseptic. It is usually given when biliary secretion seems deficient. Average dose, 0.4 gm.

MILK

Cow's Milk (N. F. 1916 to 1942; in culture media N. F. 1942 to date) is the fresh, unpasteurized or pasteurized milk of *Bos taurus* Linné, without modification, and complying with the legal standards of the state or community in which it is sold.

Cow's milk is a white, opaque liquid, being an emulsion of minute fat globules suspended in a solution of casein, albumin, lactose and inorganic salts. It has a slight but pleasant odor and an agreeable sweetish taste. Cow's milk has a specific gravity between 1.029 and 1.034 and contains from 80 to 90 per cent of water in which are dissolved about 3 per cent of casein, about 5 per cent of lactose and from 0.1 to 1 per cent of mineral salts. Milk contains from 2.5 to 5 per cent of fat (butter) and is rich in vitamins. When milk is allowed to stand a few hours the fat globules (cream) rise to the top. Each is surrounded by an albuminous layer. Upon churning, the fat globules unite to form **butter**, leaving a liquid known as **buttermilk**. The milk left after separation of the cream is known as **skimmed milk**, which if treated with rennin (see below) forms a coagulum which upon proper treatment is made into **cheese**. The liquid separated from the coagulum is known as **whey** and contains lactose and inorganic salts.

Milk is a nutrient. It is the source of lactose and kumyss.

Lac Fermentatum (N. F. 1916 to 1936), **Fermented Milk or Kumyss**, is prepared by dissolving 35 gm. of sucrose in 1 liter of milk and fermenting with compressed yeast. Fermented milk is more readily digested and absorbed than milk. It is used as a nutrient especially in cases of stomach irritability. **Condensed Milk** is prepared by partial evaporation of milk in a vacuum, and sterilization in hermetically sealed containers by autoclaving. **Malted Milk** is prepared by evaporating milk with an extract of malt. Low heat and vacuum are used so as not to destroy the enzymes present.

Casein (U. S. P. 1926 to date, and N. F. 1936 to date, as culture media) and **Sodium Caseinate or Nutrose** (N. F. 1942 to date, as culture media) are extensively used.

Lactose or Milk Sugar $C_{12}H_{22}O_{11}.H_2O$ (U. S. P. 1863 to date; N. F. 1926 to date, in culture media), is a sugar obtained from milk. The sugar is crystallized from the whey obtained in cheese manufacture.

These impure crystals are redissolved in water, decolorized with charcoal and recrystallized.

Description.—Lactose is odorless and has a faintly sweet taste. It is stable in air but readily absorbs odors. Upon hydrolysis lactose yields β-glucose and β-galactose. It reduces
an osazone (see page 113
It is not hydrolyzed by
the other sugars in the great ease with which it undergoes lactic and butyric acid fermentations.

Standards and Tests.—Lactose should be free from dextrose, sucrose, dextrin, starch and heavy metals. Consult the U. S. Pharmacopœia for constants, etc.

Uses.—*Lactose is less sweet than sucrose and is more easily broken down* It is used therefore as a nutrient in infants' food. Its principal pharmaceutical use is that of an inert diluent for other drugs.

Galactose (N. F. 1936 to date, in culture media) is obtained upon hydrolyzing lactose. **Dulcitol** (N. F. 1936 to date, in culture media) is obtained by reducing galactose.

Acidum Lacticum or Lactic Acid (U. S. P. 1863 to 1947; N. F. 1947 to date) is a mixture of lactic acid and lactic anhydride equivalent to a total of not less than 85 per cent and not more than 90 per cent of $HC_3H_5O_3$. Lactic acid is prepared by the action of the special lactic ferment (*Bacterium lactis*) on lactose, invert sugar, milk or cheese, the lactic acid formed being neutralized with chalk or zinc oxide. The calcium or zinc lactate is recrystallized and decomposed with acid. Consult the National Formulary for the properties and tests of lactic acid. Lactic acid is a caustic, a hypnotic and a stomachic.

BEEF

Extract of Beef (N. F. 1916 to date; in culture media N. F. 1926 to date and U. S. P. 1942 to date) is a residue from beef broth, obtained by extracting fresh, sound, lean beef by cooking with water, adding salt, and evaporating the broth at a low temperature, usually in a vacuum, until a thick pasty residue is obtained.

Description.—Extract of beef is a yellowish brown to dark brown, slightly acid, pasty mass having an agreeable meat-like odor and taste.

Constituents.—Extract of beef contains creatin, creatinin, carnin, carnic acid and xanthin. It is less nutritious than meat as fat, albumin, gelatin and fibrin are removed in the process of manufacture.

Standards and Tests.—Extract of beef should yield not less than 75 per cent of total solids; the ash should not exceed 30 per cent of the total solids, and the sodiu ... should not exceed 10 per cent of the total solids; the alc ...
10 per cent o ...
than 60 mg. ...
cent of the total solids, extract of beef should ...
the National Formulary for tests and methods.

Uses.—Extract of beef is a nutrient. It is used in preparing the official Elixir of Beef and Iron.

Aminoacetic Acid, Glycocoll or Glycine (U. S. P. 1942 to 1947; N. F. 1947 to date) is employed as a nutrient. Several fresh beef organs are

used in the preparation of official culture media; these include **Beef** (N.F. 1942 to date): **Veal** (N. F. 1926 to date), **Beef Heart** (N. F. 1936 to date); **Beef Liver** (N. F. 1942 to date), **Calf's Brain** (N. F. 1936 to date); **Blood** (U. S. P. 1936 to 1942 and N. F. 1936 to date); **Dried Blood Serum** (N. F. 1926 to date) and **Ascitic Fluid** (N. F. 1936 to date). **Peptone** is extensively used in culture media (U. S. P. 1916 to 1926 and 1936 to date, N. F. 1926 to date). **Creatinine** is employed as a reference standard (N. F. 1947 to date).

Allied Drugs.—Among other drugs yielded by *Bos taurus*, the following might be mentioned. **Oleum Bubulum or Neat's Foot Oil** (U. S. P. 1831 to 1873) is a fixed oil obtained by boiling the fatty tissue of the feet of the ox (deprived of the hoofs) in water, and skimming off the oil. It is yellowish, has a peculiar odor and is used for softening leather. **Sanguis or Blood**, is the arterial blood of the ox. When evaporated to dryness, it yields **Extractum Sanguis, Pulvis Sanguis or Dried Blood**, which has been used as a restorative.

ENZYMES

Enzymes are organic catalysts produced by living organisms. They make possible the many complex chemical reactions which make up life processes. Although produced by living organisms, they are themselves lifeless. They may be isolated and when so obtained still exert their characteristic catalytic effect. While very little is known regarding their chemical constitution, they do exhibit several properties in common: they are colloids and are soluble in water and dilute alcohol but are precipitated by concentrated alcohol, most enzymes act best at temperatures between 35° and 40° C; temperatures above 65° C. especially in the presence of moisture, usually completely destroy them while at 0° their activity is negligible; certain heavy metals, formaldehyde and free iodine retard their activity. Their activity is markedly affected by the pH of the medium in which they act or by the presence of other substances in this medium; and they are usually highly selective in their action. Some of the enzymes have been demonstrated to be proteins although very little is known concerning their chemical constitution. They are therefore usually classified as to their selective action; thus, amylolytic, proteolytic and lipolytic are enzymes which split starch, proteins and fats respectively. They may also be classified according to the type of chemical change which they accelerate, such as hydrolysis, fermentation or oxidation, thus invertase hydrolyzes starch; lipase, fats; and pepsin, proteins, while zymase is a typical fermenting enzyme. Enzymes often occur in combination with inorganic or organic substances that accelerate their action. These substances are known as co-enzymes and it has recently been shown that the co-enzymes are integral components of a large number of enzyme systems. Several vitamins (vitamin B_1, riboflavin and nicotinic acid) are recognized as having a co-enzymatic function.

The nomenclature of enzymes is variable, though the terms used to designate enzymes usually end in *ase* or *in*. The more important and better known enzymes are presented as follows:

I. The **Amylolytic** enzymes or **Carbohydrases**

Diastase (U. S. P. 1916 to 1926), together with **amylase**, terms applied to several well-known amylolytic enzymes. Salivary diastase, or **ptyalin** and pancreatic diastase or **amylopsin** are enzymes found in the digestive tract of animals. **Malt diastase** is formed during the germination of barley grains *Diastase converts starch into maltose. It is most active in solutions which are* approximately neutral, a reaction of pH 4 destroying the enzyme.

Invertase or Sucrase, is found in yeast, and in the intestinal juices. It brings about the hydrolysis of sucrose into glucose and fructose. **Maltase** which causes the conversion of maltose into glucose is also found in yeast and the intestinal *juices.*

Zymase is a fermenting enzyme causing the breaking up of monosaccharides (glucose, fructose) into alcohol and carbon dioxide.

Myrosin is found in white and black mustard and hydrolyzes sinalbin and sinigrin as well as other glycosides.

II. The **Esterases** include those enzymes that split esters. The group includes the *liptolytic* enzymes

Lipase is a lipolytic enzyme widely distributed in the animal and vegetable kingdoms ... the oily seeds.

... obtained from soy beans, is used as a laboratory reagent for converting urea to ammonia.

III. The **proteolytic** enzymes

Pepsin is a proteolytic enzyme found in the gastric juice. It operates best at a pH of about 1 8 and in neutral or alkaline media is entirely inactive. It converts proteins into proteoses and peptones.

Trypsin is formed from the pro-enzyme or zymogen, trypsinogen, when acted upon by the enterokinase of the intestinal juices. *Trypsinogen is found in the* pancreatic juice Trypsin is a proteolytic enzyme which is considerably more active than pepsin, converting proteoses and peptones into polypeptids and amino acids. It acts best in an alkaline medium of about pH 8, and may thus be distinguished from pepsin which acts only in acid media.

***Erepsin** is a proteolytic enzyme also found* in the intestinal juices. It converts proteoses and peptones into amino acids.

Rennin is a coagulating enzyme present in the mucous membrane of the stomach of mammals. ...

Papain is a mixt ... in the unripe fruit of the pawpaw tr... resent in **Papain** is **Peptidase I** which ... dipeptides.

IV. The **oxidizing** enzymes ... They bring about the oxi... its upon bruising. ... blood into the insoluble ...

Enzymes, as a group, have been discussed at this point ... connection with the three following drugs, Rennin, Pepsin and Pancreatin.

RENNIN

Rennin (N. F. 1916 to date) is the partially purified milk-curdling enzyme obtained from the glandular layer of the stomach of the calf, *Bos taurus* Linné. *Rennin may be prepared* by macerating the minced

glandular layer of the digestive stomach of the calf in 0.5 per cent sodium chloride solution, filtering, acidifying the filtrate with hydrochloric acid and saturating it with sodium chloride. The enzyme is precipitated by the sodium chloride, separated, dried and powdered In commerce it is prepared by a variety of processes which are more or less trade secrets.

DESCRIPTION.—Rennin occurs as a grayish white or yellowish white powder, or as pale yellow grains or scales, having a characteristic and slightly saline

sses a coagulating activity of not less
0 per cent of the Reference Rennin.

(Reference Rennin is a carefully preserved, stable, powdered rennin that has been repeatedly tested for a number of years so that its stability and its standard are definitely established. It is used as a reference standard in the rennin assay on the bas
own weigh
be brough
chloride.
blue color

USES.—Rennin is used to coagulate milk, thus preparing it as a food for convalescents It is also used as a digestant in the official Elixir of Pepsin and Rennin. Its principal use, however, is to coagulate milk for the manufacture of cheese.

SUIDÆ OR SWINE FAMILY

This family includes the non-ruminating cloven-hoofed ungulates having a thick skin bearing bristle-like hairs and having incisor, canine, premolar and molar teeth in both jaws. They have no horns The domesticated races are called hogs.

PEPSIN

Pepsin (N. F. 1888 to 1896; U. S. P. 1894 to 1942, N. F. 1942 to date) is a substance containing a proteolytic enzyme obtained from the glandular layer of the fresh stomach of the hog *Sus scrofa* var. *domesticus* Gray. The generic name *Sus* is from the Greek *Us* meaning hog, *scrofa* is Latin for breeding sow, and *domesticus* is from the Latin meaning the household.

Pepsin is prepared by digesting the minced stomach linings with hydrochloric acid. This solution is clarified, partially evaporated, dialyzed, concentrated and either poured on glass plates to dry, thus forming **scale pepsin** or carefully evaporated in a vacuum to form **spongy pepsin.**

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odor, and having a slightly acid or saline taste.
Formulary

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USES AND DOSE.—Pepsin is administered to assist gastric digestion. It should be given after meals and followed by a dose of hydrochloric acid. Average dose, 0.5 gm.

PANCREATIN

Pancreatin (N. F. 1888 to 1896; U. S. P. 1894 to date) is a substance, containing enzymes, principally amylopsin, trypsin and steapsin, obtained from the fresh pancreas of the hog, *Sus scrofa* var. *domesticus* Gray or of the ox, *Bos taurus* Linné. The pancreas is a gland lying just inside the posterior wall of the abdomen. The fresh glands are minced and extracted by methods similar to those employed in the manufacture of pepsin. As is the case with pepsin and rennin, the methods used for obtaining pancreatin are especially developed and carefully kept secret by the manufacturers.

DESCRIPTION.—Pancreatin is a cream-colored amorphous powder having a faint, characteristic, but n
or faintly alkaline solution.
of alkali hydroxides render
its action. Consult the U. S. Pharmacopœia for its properties and tests.

CONSTITUENTS.—Pancreatin contains three enzymes, amylopsin (amylase), trypsin and steapsin (lipase). The action of these enzymes as well as those of rennin and pepsin are discussed in the section on Enzymes, page 689.

USES AND DOSE.—Pancreatin is used as a digestant and in the preparation of pre-digested foods for invalids. Recently, enteric-coated granules of Pancreatin have been used in treating infants with celiac disease and related pancreatic deficiencies. Average dose, 0.5 gm.

LARD

Lard (U. S. P. 1820 to date) is the purified internal fat of the abdomen of the hog, *Sus scrofa* var. *domesticus* Gray. The fat from the mesentery, omentum and kidneys is separated from blood-vessels and adhering tissue. This is cut into small pieces and melted in steam kettles at a temperature usually not exceeding 57° C. The melted fat is washed with water and after rising to the top is run off, dried with low heat, strained and allowed to solidify.

DESCRIPTION.—Lard is a soft, white, unctuous mass, having a faint odor, and a bland taste. It is free from rancidity, melts at 36° to 42° C., forming a clear liquid from which no aqueous layer separates. It has a saponification value of not less than 195 and not more than 203 and an iodine value of not less than 46 and not more than 70 Consult the U. S. Pharmacopœia for further properties and requirements.

CONSTITUENTS.—Lard contains about 60 per cent of olein and about 40 per cent of myristicin, stearin and palmitin. The olein being liquid may be separated by pressure at 0° C, and when so separated is known as lard oil. The solid mixture of myristicin, stearin and palmitin is sold as stearin. ...d fats and

STANDAR
beef stearir ... rates.

USES.—I ... nt of
It has a tendency to become rancid and is often combined with ...
Siam benzoin (see **Benzoinated Lard,** U. S P. 1863 to date).

...ard Oil *(U. S. P. 1882 to 1916) is an oil consisting mainly of olein, expressed* ... lard and used chiefly as a lubricant and illuminant.

GELATIN

Gelatin (U. S. P. 1905 to date; in culture media N. F. 1926 to date; as a reagent U. S. P. 1894 to date and N. F. 1936 to date) is a product obtained by the partial hydrolysis of collagen, derived from the skin, white connective tissue, and bones of animals. Commercially, gelatin is prepared from the suitable by-products of slaughtered cattle, sheep and hogs. Bones are first decalcified by treatment with hydrochloric acid. The materials are extracted with boiling water and steam under pressure until the collagen is hydrolyzed. The solution is then filtered by electro-osmosis, concentrated under reduced pressure, allowed to jell and rapidly dried on netting in currents of warm air.

Description.—Gelatin occurs in sheets, flakes, shreds or as a coarse or fine powder. It is colorless or yellowish and has a very slight, characteristic odor and taste When dry it is stable in the air, but when moist or in solution it is subject to bacterial decomposition Gelatin is insoluble in cold water but swells and softens when immersed in it, gradually absorbing from 5 to 10 times its

gelatin solution form a non-flowing jelly at 10° C. when prepared as directed A hot solution (1 to 40) should be free from putrid odor. Gelatin must meet

ammonia, filtering and evaporating Keratin occurs in yellowish thick scales which are soluble in alkalis and strong acetic acid but insoluble in water and dilute acids It has been used as an enteric coating for pills and tablets

Cornu Cervi or Hartshorn (U S P. 1820 to 1842) consists of the horns of

its principal use is for preparing animal charcoal (boneblack) Being high in phosphates, it is often ground (bone-meal) and used as fertilizer

PURIFIED ANIMAL CHARCOAL

Purified Animal Charcoal (U S. P. 1831 to 1916, as Animal Charcoal; U. S. P. 1842 to 1916 as Purified Animal Charcoal, N. F. 1926 to date) is charcoal prepared from bone and purified by removing the substances

which are dissolved by hot hydrochloric acid and water. Bones are boiled in water to remove fat and then heated in iron cylinders without access of air. The charcoal thus obtained is boiled with hydrochloric acid, thoroughly washed and dried.

DESCRIPTION.—Purified animal charcoal is a dull black, amorphous, odorless and tasteless powder, which burns with a red glow but without a flame.

CONSTITUENTS.—Purified animal charcoal consists principally of carbon in such a form as to exhibit high adsorptive power.

STANDARDS AND TESTS.—Purified animal charcoal should yield not more than 4 per cent of ash and not more than 12 per cent of water. It must meet the requirements of the National Formulary for complete carbonization, impurities soluble in hydrochloric acid and adsorptive power.

USES.—Purified animal charcoal is used because of its high adsorptive power. For internal use it is usually compressed into tablets where it functions in the adsorption of gases. It is frequently administered in poisoning by alkaloids, heavy metals, etc. Large quantities are used for industrial purposes in the adsorption of coloring matter and the clarification and decolorizing of such products as sugar.

ENDOCRINE PRODUCTS

By an endocrine, or "ductless" gland, we mean a secreting organ, *present in the mammalian body, which elaborates one* or more metabolically active principles (hormones) and passes these directly to the blood stream. In some instances, mixed glands (pancreas, liver) also serve exocrine functions in passing secretions into hollow organs by means of duct systems.

The hormones so elaborated exert profound and essential influences regulating processes of metabolism, general growth and development, and the growth, development and function of the organs and characteristics of sex and reproduction. The word "hormone" infers an excitation—occasionally, the inhibitory principles are described as "chalones." This distinction is not generally observed.

Most of our present knowledge of endocrine function and therapy is the result of intensive investigations of the past forty years. In spite of the tremendous progress made to date, the picture is yet far from completion, and a rational basis for endocrine therapy cannot be established in all cases. Early therapy made use of dried glandular products, and of crude extracts prepared from them; wherever possible, therapy has been improved by the isolation of active principles, and by the synthesis of these and of related compounds modifying or extending the action of the native hormones. Products at present available for endocrine and hormonal therapy are therefore derived from:

1. By-products in the slaughter-house processing of cattle, hogs, and sheep. From these, powdered glands, gland extracts, and purified hormones have been prepared.
2. Synthetic products which duplicate (epinephrine, thyroxin), or closely mimic (stilbestrol, hexestrol, dihydrotachysterol) the actions of natural hormones.

Historical.—Our present endocrine therapy is the outgrowth of the more primitive practice of Organotherapy; therapy with organ products

or extracts. Primitive medicine men of all ages have used the organs of strong animals to remedy diseases of those organs in man—the doctrine that "lung cures lung" so well expressed by Vicary who in the sixteenth century said, "In what part of the body the faculty which you would strengthen lies, take the same part of the body of another creature in whom the faculty is strong, as a medicine." An outstanding example of this is the use of human skull in epilepsy, extolled by Paracelsus in the sixteenth century. Oddly enough, the use of toad skins in early Chinese medicine has received modern support in the finding of epinephrine-like and digitalis-like principles in these skins. The use of powdered hog testis in male impotence, and the use of rabbit uterus in treating female sterility, by Magnus in the thirteenth century, are more nearly related to our present endocrinology.

General Considerations.—It should be borne in mind that the various endocrine glands function in close harmony, correlated with the more immediate functions of the central and autonomic nervous systems. For study, some isolation is necessary, yet artificial. It is obvious then that a primary focus of disturbance will have far-reaching influence, and as a result of this, an irrational use of complex products is frequently observed.

Disturbance in the function of an endocrine gland may take the form of excessive activity (hyperfunction), or diminished activity (hypofunction), to any degree. In the treatment of such disturbances, we must look upon the endocrine products as drugs, use of which should be based upon sound, rational considerations. The following points should be noted in summary:

1. Microscopy of glandular products is not too feasible The fresh glands do not enter the general market, in the preparation of powders and extracts, most of the histologic features are lost. Standardization is usually effected by means of biologic assay, with the development of pure principles, there is increasing use of chemical means of assay, and a commendable tendency to substitute weight units for assay units in dosage.
2. The hormones are not species specific Thus, products obtained from domesticated food animals are effective in treating diseases in man. Such therapy does not always bear out the predictions of physiologic investigation, due among other things to a frequent inability to limit action, or to control side effects.
3. Hormones do not "excite" or "cure" a diseased gland. Therapeutic use depends essentially upon two types of action:
   (*a*) Replacement of existing deficiency.
   (*b*) Pharmacologic action upon non-endocrine structures.

Replacement therapy is applied to the relief of symptoms resulting [illegible]

tions in body function.

The Pancreas, and Insulin Products

The bulk of the pancreas is an exocrine gland, supplying digestive enzymes to the duodenum. Isolated groups of cells, the islets of Langerhans comprising about 3 per cent of the gland, produce the hormonal function inherent in preparations of Insulin. This hormone known as insulin:

1. Functions as a necessary factor in the cellular oxidation of glucose, and secondarily in the metabolism of fats.
2. Is necessary in the storage of glycogen by liver and muscle cells.
3. Actively inhibits the formation of glucose from fats and protein.

Deficiency of insulin in man results in the condition known as *diabetes mellitus*. This condition was described by Auretaeus in the first century A.D. as a siphoning of flesh into urine; it is characterized by a high blood-glucose level (hyperglycemia), excess glucose in the urine (glucosuria), and diuresis, resulting in dehydration and constipation. Oxidation of carbohydrate is impaired; the resulting impaired oxidation of fats produces an accumulation of betahydroxybutyric acid, diacetic acid, and other fat breakdown products in the blood. The diabetic therefore suffers severe acidosis, depression, coma, and death if untreated.

Treatment of diabetes mellitus with insulin is replacement therapy, not a cure. Insulin prolongs life in the diabetic, and permits a fuller and happier life, but its use does not cure or prevent the disease. Insulin is especially valuable in preventing the complications of diabetes so frequently the cause of death: arteriosclerosis with hypertension, nephritis, superficial ulcers and infections, gangrene of the extremities, and gallstones. A fatty degeneration of the liver has been ascribed to the lack of a second pancreatic hormone, *lipocaic*, by some workers; others consider lipocaic identical with choline.

Conditions of hyperinsulinism are known, and may result from overdosage of insulin, underfeeding, tumors of the pancreas, or certain pituitary or adrenal disturbances. Outstanding symptoms are fatigue, hunger, marked sweating, and convulsions.

In the management of diabetes mellitus due to insulin deficiency, an adequate diet is determined, and the amount and spacing of insulin dosage is established to keep the patient symptom-free and free from glucosuria. One U. S. P. unit of insulin is capable of causing the metabolism of approximately 1.5 grams of glucose. Overdosage of insulin is applied to the development of convulsive shock in treating schizophrenic states.

Insulin is a protein, with a molecular weight of about 35,000. It was crystallized in 1926 by the addition of traces of zinc, and crystals of zinc insulin form the Reference Standard of the U. S. P. Potency is determined by comparing the hypoglycemic actions of unknown and Reference Standard insulins in selected rabbits by the official procedure. One U. S. P. unit of insulin activity is equal to the activity of the amount of Reference Standard Zinc Insulin Crystals stated on the label of the official Reference Standard. The potency of this Reference Standard ranges from 22 to 26 such units per milligram.

The iso-electric point of zinc insulin is at 5.1 to 5.3. Thus, it is soluble at the alkaline pH of tissue fluids, and is rapidly absorbed from subcutaneous injection sites. Insulin is digested by proteolytic enzymes, hence is ineffective when given orally.

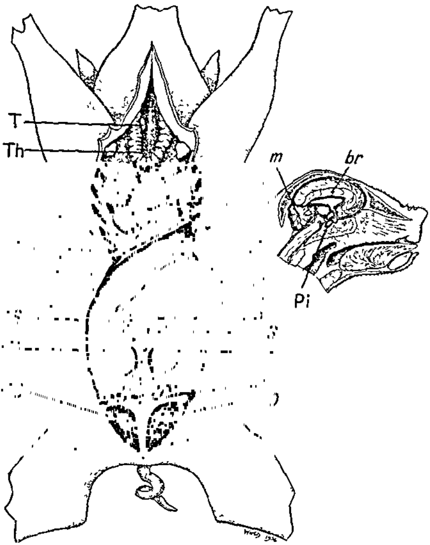

FIG. 370 —Diagrammatic sketches of the hog illustrating the location of the principal endocrine glands *T*, thyroid, *Th*, thymus, *ri S*, right suprarenal gland, *le S*, left supra-

Insulin Injection (U. S P 1942 to date) is an acidified solution of the active principle of the pancreas which affects the metabolism of glucose. It is described and standardized in the Pharmacopœia.

Insulin Injection provides rapid action by subcutaneous injection, with peak of action at two to four hours, and some effect over ten to twelve hours.

Protamine Zinc-insulin Injection (U. S. P. 1947 to date) is a suspension, in a buffered water medium, of insulin modified by the addition of zinc chloride and protamine. The protamine is prepared from the sperm or from the mature testes of fish belonging to the genera *Oncorhynchus, Suckley, Salmo* or *Trutta*.

Protamines are basic proteins—they combine with insulin to form protamine-insulin salts, stabilized by a trace of zinc. This complex has an iso-electric point of approximately 7.3—it is buffered to this point, and dispensed in a smooth suspension. When injected subcutaneously, it is insoluble at the pH of tissue fluids, and is therefore slowly absorbed to provide a prolonged action. Peak of action occurs at twelve to twenty-four hours, with some effect manifest over twenty-eight to thirty hours.

Modified Insulin (Unofficial).—This form is made by mixing the regular insulin solution with a suspension of protamine-zinc insulin, to provide in a single injection both immediate and prolonged control.

Globin Insulin With Zinc (N. N. R).—This product resembles Protamine-zinc Insulin Injection, and affords an action intermediate in onset and duration between that of regular insulin and of protamine zinc insulin. It is marketed in solution, but is insoluble at the pH of tissue fluids and is therefore slowed in its absorption. Maximum effect occurs at eight to twelve hours. A similar Histone-insulin with Zinc has not as yet achieved recognition.

Preparations of insulin are marketed in multiple-dose ampuls of varying unitage. Package color of commercial preparations varies with unit value, and the corresponding colors are listed in the current N. N. R.

Pituitary Body (Cerebral Hypophysis)

The human pituitary body is situated in a small cavity in the sphenoid bone at the base of the skull, and is attached to the base of the brain by a short stalk; it weighs about 0.5 gm. Galen considered it a strainer for spinal fluid, and Vesalius later thought it to be the source of mucus, lubricating the nasopharynx. Pituitary is from *pituita*—Latin for slime, or mucus. Modern information on pituitary function has been acquired within the past thirty to forty years.

The pituitary body is in reality two glands, by origin and function:

1. The anterior lobe is ectodermal in origin—derived from an out-pouching from the primitive pharynx.
2. The posterior lobe is neural in origin—derived from an out-pouching of the base of the brain.

A. Posterior Lobe.—Considerable uncertainty remains concerning the physiologic function and necessity of this part of the pituitary body. Extracts of posterior pituitary lobe exhibit the following effects in experimental animals and in man:

1. A pressor effect, due to arteriolar and capillary vasoconstriction;
2. Direct stimulation of smooth muscle, seen in the intact animal, or in preparations of isolated muscles;
3. An antidiuretic action, effected by increasing the tubular resorption of water in the kidney;
4. Metabolic effects, manifest in a lowered metabolic rate, and an antagonism to insulin.

These effects are all present in commercial preparations of the posterior pituitary lobe. Such preparations in therapeutic application have the disadvantage of unwanted side effects which may interdict their use. Fractionation of such extracts has produced two relatively pure hormonal preparations or fractions:

1. Pitocin (Oxytocin, Alphahypophamine) is the uterine-stimulating fraction, relatively free from action on other smooth muscle. It is especially active on the pregnant uterus, sensitized by estrogen.
2. Pitressin (Vasopressin, Betahypophamine). This fraction directly stimulates vascular, intestinal, and respiratory smooth muscle, and contains the antidiuretic principle.

The metabolic effects described above are present in both the pitocin and the pitressin fractions.

Official preparations of posterior pituitary are assayed for oxytocic activity on the isolated uterus of the virgin guinea-pig, in direct comparison with the Reference Standard Posterior Pituitary Powder of the Pharmacopœia. One U. S. P unit of oxytocic activity is represented by 0.5 mg. of this Reference Standard by official assay. Pressor and antidiuretic activities in individual lots of posterior pituitary are not assayed, but tend to parallel oxytocic activity

Pending final elucidation of posterior pituitary function, the following activities seem consistent with our present knowledge:

1. Some influence in the onset of labor at the termination of pregnancy; probably involving stimulus to a uterus sensitized by estrogen.
2. Some influence in the control of water balance by regulating the renal threshold for water.

No clinical conditions have yet been associated with hyperfunction of posterior pituitary. A deficiency state is seen only in the condition of *diabetes insipidus* which follows a deficiency of the antidiuretic principle.

Diabetes insipidus (literally an outpouring of tasteless urine) is characterized by a failure of renal resorption of water—there is a tremendous diuresis, with associated tremendous thirst and water intake This condition must not be confused with the diabetes mellitus of insulin deficiency

Preparations of posterior pituitary find therapeutic application as follows:

1. Replacement therapy in the management of diabetes insipidus.
2. Pharmacologic actions:
   (*a*) Stimulation to the postpartum uterus to lessen hemorrhage.

(*b*) Stimulation to depressed intestinal tonus, as may be seen following abdominal surgery.

Pitocin is generally preferred for the effects of posterior pituitary on the uterus, since its use avoids side-effects on the gut and circulation. Ergonovine is replacing some of the use of pituitary in the prevention of postpartum hemorrhage.

Whole Pituitary (N. F. 1936 to date).—The dried, partially defatted and powdered pituitary gland of cattle, sheep, or swine.

Posterior Pituitary (*U. S. P. 1916 to date*).—The cleaned, dried, and powdered posterior lobe from the pituitary body of domesticated food animals. By official assay, 1 mg. of this powder represents the activity of not less than 1 U. S. P. posterior pituitary unit.

These *preparations, intended for oral therapy, are considered* unreliable, inasmuch as the active principles are protein-like in character and are inactivated in the gastro-intestinal tract.

Posterior Pituitary Injection (U. S. P. 1916 to date) (Pituitrin).—A sterile, aqueous, injectable solution of the active principles of fresh posterior pituitary lobes from domesticated food animals.

This preparation represents the total activity of posterior pituitary. It is biologically standardized as described in the Pharmacopœia so that 1 cc. is equivalent to 10 U. S. P. units of oxytocic activity. In spite of the danger of undesirable side-effects on the gut, blood-pressure, the coronary arteries and the bronchioles, this preparation is frequently used in obstetrics for its oxytocic action.

Ampuls Pitressin (N. N. R.).—An aqueous solution of the pressor and antidiuretic principles of posterior pituitary (*Betahypophamine*). This preparation is unofficially standardized so that 1 cc. has a pressor activity equal to that exerted by 10 mg. of the U. S. P. Reference Posterior Pituitary Powder. This is twice the pressor activity of the official *Posterior Pituitary Injection. Ampuls* of Pitressin afford less than one unit of oxytocic activity per cubic centimeter.

Pitressin Tannate in Oil (N. N. R.).—A suspension of a tannate of the pressor and antidiuretic principles of posterior pituitary in a vegetable oil. This preparation is unofficially standardized to represent 5 pressor units per cubic centimeter—the pressor activity of 2.5 mg. *of U. S. P.* Reference Standard Posterior Pituitary Powder. It is particularly recommended in the maintenance treatment of diabetes insipidus. Intramuscular injections of 0.3 to 1 cc. at intervals of thirty-six to forty-eight hours provide adequate *relief in the* usual cases, due to slow, prolonged absorption from the oil vehicle.

Ampuls of Pitocin (N. N. R.).—An aqueous solution of the oxytocic principles of posterior pituitary (Alphahypophamine). One cubic centimeter represents the activity of 10 U. S. P. oxytocic units, with not more than one-half pressor unit.

B. **Anterior Lobe.**—This part of the pituitary body exerts a profound influence in the growth and development of the body and of its sex characters, both by direct hormonal activity, and through its stimulating actions on the other endocrine glands. A bit fancifully, anterior

pituitary has been referred to as the "master-gland," the "conductor of the endocrine symphony." As many as 18 functions have been ascribed to it. Of these, many are disputed, and many may be duplications. There is general agreement on the presence of.

1. One or more growth hormones. None of these has been isolated as yet. *Overactivity of this part of anterior pituitary* function during the growing period produces *giantism;* in the adult the picture is that of *acromegaly* Hypofunction of the growth-stimulating activity during the growing period produces the *pituitary dwarf*—in the adult, such deficiency often results in an increased delicacy of structure referred to as *acromicria*

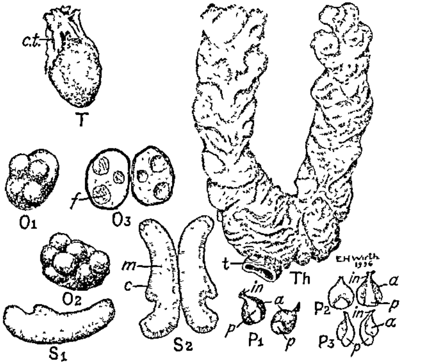

FIG 371.—Endocrine glands of the hog *T*, a lobe of the thyroid (a gland consisting of two lobes [illegible] attached connective [illegible] y from a young [illegible] he follicles (*f*), [illegible] (*m*) and cortex [illegible]), *P*₂, pituitary gland cut medianly more on the posterior side, *P*₃, pituitary gland cut dorsiventrally, *p*, posterior lobe; *a*, anterior lobe, *in*, infundibulum The sketches are one-half natural size (Drawings by Wirth)

2. At least two gonadotropic activities:
   (*a*) The follicle-stimulating action, necessary to the ripening of the ovarian follicles, and to the maturation of the seminiferous tubules of the testes.
   (*b*) The luteinizing action, essential to the development and maintenance of the corpus luteum in the ovary, and apparently active in developing the gonadal cells of the testes.

In addition to these, hormones which have thyrotropic, lactogenic, diabetogenic, ketogenic, adrenotropic, and parathyrotropic activities are thought to be present. Obviously, primary disturbances in the functioning of anterior pituitary may result in widespread endocrine involvement and generalized secondary disturbances in growth, metabolism and development.

In spite of this tremendous physiologic importance, no preparations of anterior lobe have been accepted for inclusion in the Pharmacopœia or in N. N. R. This seeming contradiction is due to the present inability to isolate pure hormonal fractions from anterior pituitary. Side reactions of far-reaching significance are thus a source of danger in any preparation of this lobe. Unofficial preparations of growth hormone have been used with some success in pituitary dwarfism, but there is the attending risk of producing hyperthyroidism and sexual precocity due to the contaminating presence of thyrotropic and gonadotropic substances in commercial preparations.

Anterior Pituitary (N. F. 1936 to date).—The dried, partly defatted and powdered anterior lobe of the pituitary body of cattle, sheep or swine.

Intended for oral administration, this preparation is not reliable, and its use cannot be considered rational, since the contained hormones are readily destroyed in the gastro-intestinal tract, and since it contains an undetermined mixture of the various activities present in the total anterior lobe.

C. **Chorionic Gonadotropins** (Placental).—The blood serum of pregnant women contains a substance, elaborated by the placenta and excreted into the urine, which is similar in action to the gonadotropic action of anterior pituitary. This activity in pregnancy urines was first ascribed to substances elaborated by anterior pituitary—later, it was referred to as Prolan, or the Anterior-Pituitary-Like substance (A. P. L.), and recognized as originating in the placenta. The active substance is a water-soluble glycoprotein.

Chorionic Gonadotropin, Follutein or Korotrin, N. N. R. is the water-soluble gonadotropic substance obtained from the urine of pregnant women. It is a glycoprotein containing about 12 per cent of galactose. It is biologically standardized for gonadotropic activity in rats and mice. One international unit is that activity of 0.1 mg. of a standard powder prepared from a number of lots of human pregnancy urine. Since the material is of limited stability in solution, it is marketed in ampuls of dry powder, accompanied by ampuls of injection water.

It should be noted that chorionic gonadotropin is not truly gonadotropic in primates or human females. Follicle-stimulating and luteinizing actions are manifest in rats and mice; in the human female, follicular degeneration rather than stimulation is the usual result. Hence, Chorionic Gonadotropin is not intended for use in the human female. Its principal application is in the male, to encourage the descent of the testes into the scrotum in *cryptorchidism*. In such use, care in observation is necessary to avoid male sexual precocity.

Presence of chorionic gonadotropins in human pregnancy urines serves as the basis for the more frequently used laboratory tests for pregnancy, particularly the Aschheim-Zondek test, and the Friedman modification of this test. These tests are positive in pregnancy, and in certain tumors and other pathologic states of the uterus.

THE PARATHYROIDS

The parathyroid glands in man are usually four in number, oval, 5 to 6 mm. in length, and situated upon or imbedded in the dorsal surface of the thyroid gland. They develop and function independently of thyroid tissue. For a number of years after their discovery by Sandstrom in 1880, the parathyroids were considered to be remnants of embryonic thyroid tissue.

Parathyroid glands exert a hormonal control over calcium and phosphorus metabolism, in a manner not yet fully understood. Removal of, or deficiency of this function results in a fall in the serum calcium level, with an accompanying rise in serum inorganic phosphate

Acute deficiency results in *tetany* when the level of serum calcium falls from normal (10 to 11 mg. per cent) to around 6 to 7 mg per cent Fibrillary muscular twitching progresses to the convulsive state, culminating in death by tetanic spasm of the larynx and the muscles of respiration.

Parathyroid hyperfunction produces a condition known as von Recklinghausen's disease, characterized by bone pain, marked elevation of serum calcium with fall in serum phosphate, cystic rarefaction of bones with spontaneous fracture and deformity. The calcium removed from bone is excreted in the urine. A similar picture may result from overdosage with extracts of parathyroid gland. In either case, renal stones and calcification of soft tissues occur.

Parathyroid function is correlated with the metabolic activity of vitamin D, which increases intestinal absorption of calcium, and favors its deposition in bone There is some evidence that parathyroid influence regulates primarily the urinary excretion of phosphate, with compensatory changes in the serum calcium level; on the basis of other evidence, the mobilization of calcium is the primary action exerted by parathyroid activity.

The active principle (parathormone, paroidin) of parathyroid gland has not been isolated. It is evidently protein in nature, inactivated in the gastro-intestinal tract, and must therefore be given parenterally. Following injection, the blood calcium level rises in about four hours, reaching a maximum in about sixteen hours, and returning to normal in twenty-four to thirty-six hours Hence, one dose daily is usually sufficient.

Parathyroid Injection (U. S. P 1936 to date) is a sterile solution in water for injection of the water-soluble principle or principles of the parathyroid glands which have the property of relieving the symptom of parathyroid tetany and of increasing the calcium content of the blood

given intravenously, but such use requires careful alkalinization to effect solution, is relatively expensive, and offers no advantage over oral thyroid in the usual case. Thyroxin is seldom employed at the present time.

The effect of a single dose of thyroid orally, or of thyroxin orally or intravenously, is not manifest for some twenty-four to forty-eight hours; reaches a maximum in eight to ten days, and decreases slowly over a period of several weeks. Hence, accumulation may occur, and dosage schedules must be adjusted individually to the needs of the patient.

Adrenal Glands

The adrenals (suprarenals) in man comprise a pair of small glands, one situated over the superior medial aspect of each kidney. Each average gland measures 5 x 25 x 50 mm.; together the adrenals weigh 4 to 18 grams.

The adrenals were first described by Eustachius in the sixteenth century, and were long supposed to function in the inhibition of fetal *urination, and in the prevention of renal stones in the adult.* Knowledge of adrenal function began with Addison in 1849, and is as yet far from being completed.

Each adrenal consists embryologically, histologically and functionally of two distinct glandular entities, grossly combined into one organ:

1. The adrenal medulla is composed of cells which migrated out from the embryonic neural crest, and are analogous to the peripheral sympathetic neurons of the autonomic nervous system. Its hormone, epinephrine, is identical with or closely approximates the sympathetic *neurohormone, sympathin.* Adrenal medulla functions as a sympathetic postganglionic structure.

2. Adrenal cortex is composed of cells arising behind the primitive sex cells on the genital ridge of the embryo. Its functions in close correlation with gonadal function, and its hormones are steroids, similar in structure to the sex hormones of ovary and testis.

A. **Adrenal Medulla.**—Adrenal medulla is not essential for life, and no diseases of deficiency are known. Therapeutic use of the hormone, epinephrine, is based upon the pharmacology of the sympathicomimetic amines, rather than upon the principle of replacement. Epinephrine is a vasoconstrictor and vasopressor, acting in general as a sympathicomimetic agent of rapid onset but brief duration of action. It is capable of inhibiting isolated intestinal strips in dilutions as high as one to four million. Oral administration of epinephrine is ineffective, due to *inactivation in the stomach.*

Suprarenal, Desiccated Suprarenal or Dried Adrenal Substance (*U. S. P.* 1905 to 1926; N. F. 1936 to date) is the dried, partially defatted and [illegible] suprarenal gland of cattle, sheep or swine. Suprarenal is [illegible] ...ternal [illegible] ...it [illegible] ...r [illegible]

of natural epinephrine of glandular origin and is free from

preservatives. One part of suprarenal represents approximately 6 parts by weight of the fresh glands. If suprarenal is dried by heat, it must be dried in a vacuum, the temperature of the drying material not exceeding 60° C. The preparation is intended for oral use, but is considered archaic by most physicians.

Epinephrine (U. S. P. 1926 to date) (**Suprarenalin, Adrenalin**). A levorotatory alkaloid isolated from adrenal medulla, or prepared synthetically. Dextrorotatory epinephrine is almost completely inactive, and optically inactive mixtures have about half the activity of natural epinephrine. Epinephrine alkaloid is official for use in the preparation of solutions and other administration forms.

Epinephrine Solution or Epinephrine Hydrochloride Solution (U. S. P 1926 to date) is a solution of epinephrine in distilled water prepared with the aid of hydrochloric acid It has a potency equivalent to a solution containing 1 gm. of U. S. P Epinephrine Reference Standard in each 1000 cc. It is standardized on the basis of its pressor effect in prepared dogs, by direct comparison with Reference Standard Epinephrine.

Epinephrine Injection or Epinephrine Hydrochloride Injection (U. S. P 1942 to date) is a sterile solution of epinephrine in water for injection prepared with the aid of hydrochloric acid The injection is intended for systemic or local use by subcutaneous or intramuscular injection

Epinephrine Inhalation (U. S. P 1947 to date) is a solution of epinephrine in distilled water prepared with the aid of hydrochloric acid. It has a potency equivalent to a solution containing 1 gm. of U. S P. Epinephrine Reference Standard in each 100 cc The solution is intended only for topical application to the bronchial mucous membrane in the form of a finely vaporized spray. It affords relief in bronchial asthma with a minimum of systemic side effects It must not be confused with the weaker solutions or injections previously described

Suspension of Epinephrine in Oil (N N R)—A 1 500 suspension of epinephrine base in vegetable oil, suitable for intramuscular injection This [illegible] depot, and aff[illegible] injection. It [illegible] urticaria, and other allergic manifestations.

B **Adrenal Cortex.**—The adrenal cortex is essential to life—removal of about 85 per cent of cortical tissue results fatally in a few days In animals so treated, life may be maintained by the administration of extracts or hormones of the adrenal cortex.

Cortical deficiency in animals is marked by a loss of appetite and weight; vomiting and diarrhea, weakness; and a fall in temperature, metabolism, and blood-pressure. There is a loss of blood fluid, with resulting concentration of blood, a fall in serum sodium with a rise in serum glucose and potassium. Kidney damage is frequently present. These developments can be prevented or restored to normal by the administration of cortical extracts, and frequently by the simple use of a high sodium, low potassium intake.

The human counterpart of this deficiency picture is seen in the clinical development of *Addison's disease,* due usually to tuberculosis or tumor of the adrenal cortex. Associated with this disease, there is degeneration of the gonads, a marked increase in capillary permeability, and an increased sensitivity to insulin. Sodium loss with potassium retention may be the outstanding condition of the disease. If untreated, Addison's disease terminates fatally in one to three years, due usually to hypoglycemia, dehydration, nutritional disturbances or secondary infection.

Excessive adrenal cortical activity, as in tumors or due to the presence of accessory cortical tissue, result in profound growth abnormalities, especially seen in the external genitalia, and in the secondary sex characteristics. In young children, there is precocious sexual development and desire, with obesity or unusual muscular development. In adult females, there is commonly the development of virilism, associated with a masculine appearance, often with homosexuality. The bearded lady of the circus is frequently of this category. Treatment of cortical overactivity is principally surgical.

Some twenty or more crystalline steroids have been isolated from cortical extracts. These exhibit in some degree the action of adrenal cortex. Some in addition manifest estrogenic, androgenic, and progesterone-like activity, further indicating the close relationship between adrenal cortex and the gonads.

Corticosterone was crystallized from cortical extracts by Reichstein in 1936. It has not been synthesized, and the natural steroid is prohibitively expensive. It is present in crude cortical extracts, and functions principally in opposing insulin to restore normal blood sugar levels and glycogen storage.

Preparations of adrenal cortex are used primarily as replacement therapy in Addison's disease, and in surgical adrenal cortex deficiency. This therapy, especially using cortical extracts, is markedly improved by the use of high sodium, low potassium diet regulations. Dosage must be established in the individual, based upon need. Attempts to use cortical extracts in the management of surgical shock, based upon their action in reducing capillary permeability, are as yet experimental.

Adrenal Cortex Extract (N. N. R.) is an extract of adrenal glands, from domesticated animals used as food in man, containing the cortical steroids essential for the maintenance of life in adrenalectomized animals. Only traces of epinephrine are present.

Desoxycorticosterone Acetate (U. S. P. 1947 to date).—This steroid was identified in cortical extracts by Reichstein and his associates in 1938, and later was synthesized from stigmasterol. Material in present use is the synthetic product, due to the greater cost of the natural hormone.

Cortical extracts are effective when given orally, but better and more uniform results follow the intramuscular injection of desoxycorticosterone dissolved in sterile vegetable oil. Pellets have been successfully implanted in the subcutaneous tissues for even more prolonged action. Desoxycorticosterone is relatively ineffective orally.

Desoxycorticosterone functions primarily in restoring a balance of sodium and potassium in body fluids, and in restoring kidney function, in cortical deficiency. Death from hypoglycemia may occur in Addison's disease treated with desoxycorticosterone alone; such cases require the use of cortical extracts.

The Gonads

The ovaries and testes are exocrine (ova, sperm) as well as endocrine (hormonal) in function. They develop under the influence of anterior pituitary hormones, particularly:

1. The follicle-stimulating hormone (FSH) leads to the development of the ovarian follicles, to their formation of ova and of estrogen, and to the development of the testes and the maturation of the spermatozoa.

2. The luteinizing harmone (LH) is necessary to the development of the corpora lutea in the ovarian follicles after ovulation, to the formation of progesterone by the corpora lutea, and to the production of androgen in the matured testis.

Androgens (male hormones) and estrogens (female follicular hormones) act to:

1. Develop and maintain the secondary characters of sex.

2. Depress anterior pituitary function, leading in turn to the depression of the testis or the ovary.

Progesterone (corpus luteum hormone) similarly depresses anterior pituitary function, and presents a mixed antagonism-synergism with estrogenic activity, as will be indicated below.

Gonadal hyperactivity, or excessive therapy may thus result in a picture of precocious or excessive sexual development, together with the generalized effects of anterior pituitary depression. Gonadal hypoactivity, as in the natural menopause, or following surgical removal of the gonads, results in a mixed picture of sexual regression, and enhanced anterior pituitary activity, with psychic disturbance, and the involvement [illegible]d.

[illegible], the sex organs a [illegible] These functions are restored by the administration of testes hormone Hypogonadism (enuchoidism) is a failure of adequate development of the testes, due to pituitary disorder, infection, or other disease. Therapy of this condition is still in the experimental stages.

Hypergonadism is most frequently seen in young males, due to testis tumors, and resul [illegible] characteristics. [illegible]

Testosterone Pr[illegible] hormone, isolated from bull's testis, or synthesized from cholesterol. Testosterone is believed to be the true testis hormone, although it has been identified only in the bull's testis (David, 1935). It was synthesized by Ruzicka from cholesterol in 1936. Androsterone and dehydro-iso-androsterone are urinary excretion products, relatively inactive in man.

Testosterone given orally is rapidly absorbed and excreted. Action is further shortened by partial destruction, probably in the liver. Better therapeutic effect is achieved by measures designed to delay the absorption, excretion, or destruction of the testosterone. Testosterone Propionate is given by intramuscular injection in doses of 25 mg.

Methyltestosterone (U. S. P. 1947 to date) given orally or sublingually, in doses of 10 mg. or 5 mg., respectively, provides prolonged activity due to a decreased rate of destruction.

Similarly, unofficial pellets of testosterone propionate have been successfully implanted under the skin. These may provide activity for a year or more; on the other hand, encapsulation in fibrous tissue may occur to render the implant valueless.

Testes hormone preparations have shown evidence of value in the replacement therapy of male castrates and enuchoid states, and in the treatment of certain female ovarian dysfunctions. Much of this therapy is still in the experimental stages. It must be remembered that testosterone is not an aphrodisiac, and that its use may produce the general effects of anterior pituitary depression. It may produce virilism in the female, and skin reactions similar to acne vulgaris rather frequently develop. Therapy with testosterone may be prohibitively expensive.

• B. **The Ovary.**—The human ovaries are paired organs, one being situated on each lateral pelvic wall, in the posterior layer of the broad ligament, behind and below the lateral extremity of each Fallopian tube (oviduct). Each is about the size and shape of an unshelled almond, and weighs about 4 to 8 grams.

Ova develop within primitive ovarian follicles (Graafian follicles) under the influence of the follicle-stimulating hormone of anterior pituitary. Ovulation with the extrusion of one ovum from a ripened follicle normally occurs each month during the child-bearing period. If pregnancy is established, the ruptured follicle undergoes cellular *change to become the corpus luteum,* under the influence of the luteinizing hormone of anterior pituitary. The ovary elaborates two types of hormone:

1. Estrogens, elaborated in the developing Graafian follicle, and probably also in the placenta during pregnancy.
2. Progestins, elaborated by the corpus luteum, and, in the latter half of pregnancy, by the placenta.

I. **Estrogens.**—*Deficiency in estrogenic activity is most frequently* manifest in the normal menopause, or following surgical removal of the ovaries. Local changes in the tissues of the vagina and vulvæ may result from estrogenic deficiency of any cause.

The estrogens are necessary to:

1. Develop and maintain secondary female sex characters.
2. Develop and maintain the uterus and the vagina.
3. Aid in the presecretory development of the mammary glands.
4. Maintain the corpus luteum of pregnancy.

Estrogens act further to excite or sensitize the uterine muscle, and to

depress the anterior pituitary function. Preparations of estrogenic substances are employed in the management of:

1. Symptoms of the natural or surgical menopause.
2. Local atrophic and degenerative changes in the adult vagina and vulva, resulting from estrogen deficiency.
3. Gonorrheal vaginitis in the young female child, by inducing an adult type of vaginal epithelium, resistant to the gonococcus.
4. Suppression of lactation in engorged, painful mammary glands, presumably by a direct action on the breast. Stilbestrol orally is most frequently employed for this purpose.
5. Prostatic cancer in the male, presumably by balancing an excessive persistence of androgen—the principle of "biochemical castration."

Ovary (N. F. 1936 to date) is the dried, undefatted, and powdered ovary of cattle, sheep or hogs. One part of Ovary represents approximately 6 parts of fresh glands.

Ovarian Residue (N. F. 1936 to date) is the dried, undefatted, and powdered ovary of cattle, sheep or hogs, from which the corpora lutea have been removed. One part of Ovarian Residue represents about 6 parts of fresh gland, without corpora lutea.

Intended for oral administration, in doses of about 0.3 gm., these preparations are of unknown potency and efficiency, and their use has been rendered more or less obsolete by the development of isolated and purified active principles and preparations.

Isolated or Purified Estrogens:

I. Crystalline estrogens of natural origin.
   Estradiol (U. S. P. 1947 to date).
   Estradiol Benzoate (U. S. P. 1942 to date).
   Estriol (estratriene, theelol) (N. N. R.).
   Estrone (theelin) (U. S. P. 1942 to date).

II. Crystallized Synthetic Estrogens.
   Diethylstilbestrol (U. S. P. 1947 to date) (Stilbestrol).
   Benzestrol (octofollin) (N. N. R.).
   Hexesterol (N. N. R.).

III. Non-crystalline Estrogens.
   Ammotin (N. N. R.).—This preparation is water-insoluble, and consists principally of estrone, extracted from pregnant mares' urine.
   Premarin (N. N. R.).—This preparation is water-soluble, and consists principally of sodium estrone sulfate, extracted from pregnant mares' urine.

The natural ovarian hormones are steroids. Alpha-estradiol is believed to be the true ovarian hormone, although it has as yet been identified only in the sows' ovary. Beta-estradiol is virtually inactive. Estradiol, U. S. P. is alpha-estradiol, prepared by the reduction of estrone, and possessing some 6 times the potency of the latter.

Estrone and estriol are oxidation products of estradiol, recoverable from human pregnancy urine, follicular fluid, placenta, and from the

urine of pregnancy mares. Crystalline synthetic estrogens are non-steroid derivatives of stilbene, and offer inexpensive, orally effective estrogenic activity.

Crystalline estrogens are prescribed in terms of weight, based on the individual need. The non-crystalline estrogen preparations are standardized unofficially on the uterus of the castrated female rat, one international unit representing the activity of 0.1 mg. of crystalline estrone. Other rat units vary widely and should be disregarded.

Estrogens may be administered orally, parenterally, or by inunction for systemic activity. Orally administered natural estrogens are destroyed in greater part, probably in the liver. Estriol is the best of this group for oral use—oral efficiency of estriol is about one-fifth that achieved by parenteral administration. Synthetic estrogens are cheaper, and more effective by the oral route than natural estrogen.

Given parenterally, about 90 per cent of natural estrogen is destroyed. *This factor, in addition to rapid absorption, tends to diminish* the efficiency and effective period of therapy. In the case of the crystalline synthetic estrogens, absorption is rapid, but destruction is slow, so that a more prolonged period of action is achieved. Side effects of nausea and vomiting are likewise enhanced.

Therapeutic efficiency is improved by:

1. Formation of esters, such as estradiol benzoate, and estradiol *propionate. Esterification slows destruction* and elimination, and thus prolongs the duration of effect following oral or parenteral administration.

2. Intramuscular injection of estrogen esters, dissolved or suspended in sterile vegetable oil to prolong action further by *slowing absorption.* Similarly, pellets of estrogen esters have been successfully implanted under the skin, and may be effective for months. Slowed absorption further lessens side-effects of nausea and vomiting.

3. Suppositories containing estrogenic *substances provide local treatment* of changes in the vagina or vulva, or treatment of gonorrheal vaginitis in female children, with a minimum of systemic effect.

The natural estrogens exhibit carcinogenic properties upon prolonged administration to animal strains having hereditary susceptibility to mammary cancer. There is a feeling that on this basis, estrogens should be contra-indicated in women who have a personal or family history of mammary or genital cancer. In this connection, it is interesting to note the recent experimental use of estrogens and of androgens in the treatment of certain cancers occurring in females.

II. **Corpus Luteum-progestin.**—The corpus luteum *is essential to the* maintenance of human pregnancy during the first *half of the term.* Its principal hormonal functions are:

1. Preparation of the uterine mucosa to receive the *fertilized ovum.*
2. A *necessary rôle* in the development of the maternal placenta.
3. Continuation of the development of the mammary *glands, in* preparation for the lactogenic action of anterior pituitary.
4. Suppression of ovulation for the duration of pregnancy.

5. Antagonizing the stimulating effect of estrogens on the uterine muscle, to produce a relaxation of the uterus.

Corpus Luteum (N. F. 1936 to date) is the dried, undefatted, and powdered corpus luteum from the ovary of cattle, sheep or swine. One part of corpus luteum is obtained from approximately 5 parts by weight of fresh corpus luteum.

The active hormone of the corpus luteum is believed to be progesterone, and this steroid has been synthesized from stigmasterol. It appears in pregnancy urine in an inert reduction derivative termed pregnandiol, which may be recovered and oxidized to progesterone.

Progesterone (U. S. P. 1947 to date).—This substance is ineffective when given orally, and is usually administered intramuscularly in oil solution, in doses of 5 mg.

Anhydro-hydroxyprogesterone (U. S. P. 1947 to date).—This derivative of progesterone exhibits progestin activity when given orally in doses of 10 mg.

Therapeutic usage of these progestins is not well established, and no preparations of corpus luteum or its hormones have been accepted for inclusion in N. N. R. (1946). Extracts of corpus luteum as well as the crystalline hormones have been extensively employed in the treatment of habitual abortion, in the relief of pain after childbirth, and in the relief of cramping pain associated with uterine overactivity during the menstrual period. These actions probably depend upon a relaxation of uterine muscle.

LIVER-STOMACH

These organs serve an endocrine function in collaborating to produce one or more hormonal principles essential to adequate functioning of the erythropoietic bone marrow, and to other less clearly defined functions. The essential substance is referred to as the "anti-anemia principle" (A. A. P.), or the "erythrocyte-maturing factor" (E. M. F.)

Deficiency in the supply or utilization of this hormone leads to complex disturbances centering around a severe anemia, and characterized by one or more of the following:

(*a*) Hyperchromic, macrocytic anemia (Addisonian Pernicious Anemia). This condition was described by Combe in 1822, and more fully by Addison in 1849.

(*b*) Gastro-intestinal disturbances: Smoothing and inflammation of the tongue, digestion disturbances, and diarrhea, associated with lack of gastric hydrochloric acid

(*c*) Nervous disturbances, involving particularly the spinal cord and the peripheral nerves.

(*d*) Bone marrow changes, with a cessation of erythrocyte maturation at the stage of abnormal megaloblasts.

In untreated cases, the disease progresses by repeated episodes of these changes, to a fatal termination. Adequate replacement therapy is available in oral or parenteral preparations containing the essential

hormone, prepared from the stomachs or livers, or both, of domesticated food animals.

Under conditions of normal function, the elaboration of this essential hormone may be outlined as follows:

1. An adequate diet contains an unknown substance, designated as the "extrinsic factor"—associated with but apparently not a part of the B complex of vitamins.
2. Gastric and duodenal glands secrete a substance—the "intrinsic factor"—probably a proteolytic enzyme.
3. *Interaction of these factors occurs in the small intestine.*
4. This interaction product is carried to the liver, where the ultimate hormone is elaborated and stored, pending release to the bone marrow and other organs.

Pernicious anemia may result from defects at any point between the dietary intake and the utilization of the hormone in the bone marrow. The most common defects lie in an inadequate production of intrinsic factor, and in an inadequate absorption of the interaction *product from the small intestine.*

Minot and Murphy in 1926 showed that the daily oral ingestion of 200 to 400 grams of whole liver resulted in remission of pernicious anemia, and the maintenance of a normal erythrocyte *and marrow picture.* This whole liver must be ingested raw, or at most lightly cooked, since the active hormone is destroyed by more thorough cooking. Preparations at present in use are the result of improvements in the extraction of the hormone from the livers and stomachs of food animals.

Preparations of Liver, Stomach, or Liver-stomach, are bio-assayed for their activity in inducing remission in patients suffering from active pernicious anemia in relapse. Assignment of potency is made by the *Anti-anemia Preparations Advisory Board* of the U. S. Pharmacopœia, on the basis of data supplied by the manufacturer. One U. S. P. Anti-anemia Unit is the minimum amount of the material in question which must be given daily to produce an adequate hematopoietic response, as determined by this Advisory Board.

The amount of substance necessary to provide this adequate response by oral administration is about 30 to 40 times that *required by* intramuscular injection. Hence, labelled potencies are specified in "oral" or "injectable" units, depending upon the route to be used in administering the product so labelled.

I. **Liver Extracts.**—The active material present in liver extracts has the properties of a peptide, with a molecular weight of five to ten thousand. It is water-soluble, stable at 100° C., at pH 5, *and* is readily absorbed from the intestine or from intramuscular injection sites

A. *Oral Liver Extracts.*—**Liver Extract** (U. S. P. 1936 to date) is a [illegible] that *soluble* [illegible] number [illegible] rnicious

of red blood corpuscles in the blood of persons [illegible] *Liver Extract in* anemia. The approximate anti-anemia potency of Liver Extract in pernicious anemia is expressed in U. S. P. Units (oral).

Liver Solution (U. S. P. 1936 to date) is a brownish liquid, and contains that soluble thermostable fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons affected with pernicious anemia. The approximate anti-anemia potency of Liver Solution in pernicious anemia is expressed in U. S P Units (oral).

Oral liver preparations are preferable to raw liver for therapy, but have given way largely to more purified parenteral preparations, or to oral Liver-stomach Concentrates Oral Liver Extracts are relatively expensive, often unpleasant to the point of nauseating the patient, slow, and relatively uncertain in their action. In severe cases, particularly if complicated by nausea, vomiting, diarrhea, or established nervous

frequently inadequate

—**Liver Injection** (U. S P 1947 to date)

injection of that thermostable fraction of mammalian livers which increases the number of red blood corpuscles in the blood of persons affected with pernicious anemia The approximate anti-anemia potency of Liver Injection upon intramuscular administration in pernicious anemia shall be expressed in U S. P. Units (Injectable). Liver Injection contains not more than 15 U. S P. Units (Injectable) in each cubic centimeter.

Parenteral Liver Extracts are protein-free, sterile, purified products, designed for intramuscular injection Commercial preparations are available in a range of concentrations providing 1 to 15 injectable units per cubic centimeter; at the present time, no preparation will be assigned a potency value in excess of 15 units per cubic centimeter.

Preparations of the lower potency values are preferred by many—the bulk of injected material per unit is of course greater, but these preparations of lower potency are relatively crude, and contain appreciable quantities of vitamins and of other, poorly understood fractions believed to be present in whole liver. High potency preparations are preferred in specific therapy of pernicious anemia of severe degree, or in the ... disturbances

effective dosage.

(*b*) Greater convenience of administration Patients may be taught to inject themselves, and maintenance may often be achieved on single weekly injections.

(*c*) Economy, due to more efficient utilization.

II. **Stomach Preparations.**—These consist of the dried, powdered, defatted stomach of the hog. They are intended for oral administration—no parenteral preparations of Stomach are available. These preparations contain the interaction product, resulting from the action of intrinsic factor from the mucosal glands upon the extrinsic factor contained in the muscular part of the stomach wall.

Powdered Stomach (U. S. P. 1936 to date) is the dried and powdered defatted wall of the stomach of the hog, *Sus scrofa* var. *domesticus*. It contains factors which increase the number of red blood corpuscles in

the blood of persons affected with pernicious anemia. The activity is readily destroyed when the preparation is suspended in a hot liquid. The approximate anti-anemia potency of Powdered Stomach in pernicious anemia is expressed in U. S. P. Units (oral). **Ventriculin** N. N. R. is a similar preparation.

Powdered Stomach *is more agreeable to taste than oral liver extracts,* hence produces less nausea, and may thus be more dependable—otherwise, the disadvantages of Powdered Stomach in therapy are those *outlined for oral liver preparations.*

III. **Liver-Stomach Preparations.**—These are powders, prepared in general by digesting about 3 parts by weight of crude liver extract with one part of *finely minced hog stomach mucosa. The active hormone present* is supplied in part by the liver extract, and in part by the interaction between the extrinsic factor present in the liver extract with the intrinsic *factor of the gastric mucosa. Digestion thus enhances the final anti-*anemic potency to approximately ten times that of the reacting ingredients. Liver-Stomach is the most potent of the oral anti-anemia preparations; *no parenteral preparations are available.*

Liver with Stomach (U. S. P. 1947 to date) is a brownish powder resulting from mixing a concentrated water solution of mammalian liver with minced fresh hog stomach tissue. The *fraction of* liver employed is soluble in approximately 70 per cent alcohol, by volume, and insoluble in approximately 95 per cent alcohol by volume. After admixture and incubation, the product is dried under reduced pressure, and defatted. The approximate anti-anemia potency of Liver with Stomach in pernicious anemia is expressed in U. S. P. Units (oral). Extralin N. N. R. is a similar product.

Two general points must be considered in the therapeutic use of these anti-anemia preparations of liver and stomach:

1. Their use is replacement therapy—*not curative.* Relapses may be expected to follow cessation of therapy.
2. Pernicious anemia results from a specific deficiency, supplied by the specific anti-anemia factor. The popular addition of vitamins, iron and other factors to therapy is justified only upon the basis of an established need for them—they are of no specific value in pernicious anemia.

Recent experimental studies have indicated the value of folic acid in the treatment of macrocytic anemias. This substance is probably identical with "*Vitamin Bc*" or the "*Lactobacillus casei factor*" previously reported in crude liver extracts, yeast, animal muscle, and other sources. Synthetic folic acid (Pteroylglutamic Acid) has shown experimental *promise in macrocytic anemias* associated with sprue and related conditions. (See Vitamin B, p. 675.)

POWDERED DRUGS

A very appreciable amount of the traffic in crude drugs consists of drugs that have been reduced to a powder. Milling destroys practically all means of macroscopic identification, leaving as the only means of identifying the drug the microscopic characteristics of the tissue elements and cell contents, together with their reaction toward microchemical reagents and in a few cases their odor and taste

Examination.—The powder to be examined should be so mixed as to insure a uniform sample. Before making a microscopic examination, especially in the case of coarsely comminuted material, it is desirable to mix a small quantity of the material with a little water contained in a watch crystal or small beaker and note such features as the following: (1) *If the particles sink or float.* In all genuine coffee, for instance, the particles rise to the surface, whereas in the substitutes and adulterants they sink. (2) *If the particles disintegrate* Artificial products when made from exhausted powders or spurious substances, slowly disintegrate, leaving a fine sediment. (3) *The color of the solution.* A chelidonium powder, for instance, gives a golden-yellow solution, as do also many drugs containing berberine and allied principles. (4) *Behavior of the solution and particles toward alkalis or dilute hydrochloric acid* Drugs containing hydroxymethyl-anthroquinone derivatives, as senna, rhubarb, aloe, frangula and cascara sagrada, are colored red with alkalis. The particles of ruellia give a distinct effervescence with hydrochloric acid, particularly if the mixture is slightly heated The presence or absence of starch may be determined by heating the mixture, to which has been added a few drops of diluted hydrochloric acid, filtering and adding iodine to the filtrate when cool.

The odor of the mixture, particularly on warming, is of considerable value, as in the detection of belladonna in inula or of conium in anise. The odor is also of value in recognizing the specimen, as many drugs have a characteristic odor. The odor of a specimen is, however, sometimes misleading, as a number of substances not at all related may have a similar odor. The odor of elm bark, for instance, is possessed by other substances, such as fenugreek and wheat middlings, particularly if these substances are kept in closed vessels.

The fixed oil, which occurs in considerable quantity in many seeds, often interferes with their microscopic examination and in such cases it is necessary to remove it before making mounts of the material. This can be accomplished by treating the powder with chloroform, xylol, acetone, ether or other similar solvent. Alcohol, as a rule, is not a good solvent for these oils. The solvent may be added directly to the mount and the solution absorbed by means of filter paper.

In preparing a mount for microscopic examination the following method gives good results. Place 2 or 3 drops of the reagent or mounting

medium on a clean slide. By means of a teasing needle, transfer a suitable quantity of the powder to the reagent, mixing it well with the liquid. Place the cover-glass, allowing one edge to touch the slide first, and by light pressure with the finger move the cover-slip in rotary

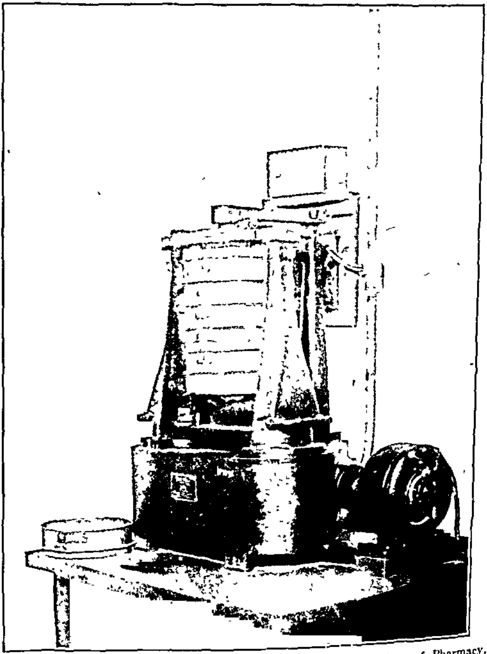

FIG. 372.—Ro-Tap Sieve Shaker. Drug Milling Laboratory, College of Pharmacy, University of Minnesota.

motion to ensure an even distribution of the powder beneath it. Both the amount of powder and the amount of reagent to use must be learned by experience. A properly prepared mount will just fill the space between slide and cover-glass and will be but slightly opaque.

The proper reagent or mounting medium to be used depends upon

the characteristic tissue element sought. Tracheal tissue, bast, wood fibers and sclerenchyma tissue generally give a red reaction with phloroglucin-hydrochloric acid. Chloral T.S. serves as a clearing agent and is not applicable to the study of starch grains, but is very useful in the study of mechanical tissues, hairs and calcium oxalate. The clearing [illegible] the cover-glass [illegible] starch microscopically, care should be taken that the reagent is not too concentrated. A preferable way of performing this test is to mount the powder in water in the usual way. A drop of iodine solution is then placed on the slide at one side of the cover-glass and drawn under it by means of a piece of filter paper applied at the opposite side. The characteristic blue (not black) is noted when the reagent first comes in contact with the starch grains. Among other special reagent solutions are ammonio-ferric alum and ferric chloride for tannins, alkalis for the anthraquinine derivatives and zinc chloriodide for cellulose and suberized tissue.

Identification Key.—Many of the powdered drugs, spices and other food products resemble each other closely as to form, color and other properties and it is therefore necessary that some outline for their identification be prepared. The most logical key for such a purpose is one based upon the histological characteristics of the powders and their reaction toward micro-chemical reagents. Keys based upon organoleptic observation, especially color, are unsatisfactory because of the rather wide variations which frequently exist. The key given herewith is based primarily upon the phloroglucin-hydrochloric acid test, the presence of starch and the presence of calcium oxalate, with further subdivisions depending upon anatomical characteristics. The key will be found helpful in practice and will render expeditious the examination of unknown powders.

Procedure.—After a preliminary examination the powder is mounted in phloroglucin-hydrochloric acid and the presence or absence of lignified tissue noted. The presence or absence of starch, if not already determined in the preliminary examination, is now to be determined and checked microscopically by means of water mounts. Calcium oxalate crystals are best seen in a chloral T.S. mount, and in this connection the micropolariscope will aid very materially. The suspected crystal is brought into focus with the analyzer so turned as to allow maximum light. The analyzer is then turned to such a position as to shut out all light from the field; the crystal will then appear brilliant against a black background. It must be remembered, however, that mechanical tissue and hairs often show similar deflection of polarized light. If calcium oxalate is suspected another mount is made in water and the crystals located. A drop or two of hydrochloric acid is then drawn under the cover-glass and its action upon the crystal observed. Calcium oxalate will dissolve without effervescence. The material most likely to be mistaken for calcium oxalate is sand. As a rule, sand shows no definite crystalline structure but may in some cases resemble that of prisms. It is *not* soluble in hydrochloric acid. In connection with the identifica-

tion of calcium oxalate, the crystalline form, whether rosette aggregate, prismatic, raphide or sphenoidal microcrystalline, is observed.

With the determination of the presence or absence of lignified tissue, starch and calcium oxalate, the position of the unknown powder in one of the fundamental groups of the key is established. From now on it must be traced by a process of elimination depending upon the presence or absence of certain characteristic tissue elements. As an example, let us assume that we have found lignified tissue, starch and calcium oxalate in the form of rosettes present. Consulting the key, we next look for fibers and stone cells. Let us assume that we find relatively large stone cells but no fibers. This eliminates the groups headed "Fibers and Stone Cells present" and "Fibers present. Stone Cells absent" and brings us down to the group "Stone Cells present, Fibers absent," thus eliminating all but four possibilities. Upon measuring our stone cells we find them to be about 0.250 mm. in diameter. This identifies our unknown powder as granatum. After the powder has been identified by the use of the key, its description in the text should be consulted and a subsequent comparison made. Final comparison with an authentic sample cannot be too strongly urged.

Notes on the Key.—The key includes the more important U. S. P. and N. F. drugs occurring in powdered form, together with several other commonly occurring powdered substances. It is designed to be used in the identification of *pure* powders, and in this case the analyst must use discretion. A pure sample of bark drug contains no woody elements, yet in practice a small amount of woody tissue is occasionally found admixed with the drug. Such a drug is placed in the key under the heading "Tracheæ absent." In a similar manner stone cells in powdered clove, or rosettes of calcium oxalate in pimenta are occasionally found owing to admixture of stems.

As has been previously mentioned, color, odor and taste, while not adaptable as a means of forming subdivisions, are very useful as a check. The ultimate goal to be reached is the identification of the powder and the more ways in which this may be checked the more correct will be the result. In this connection too much stress cannot be laid upon special micro-chemical and other tests which may be found in the individual monographs in the text. Many drugs contain sublimable constituents which give characteristic crystals, and these in turn give characteristic reactions with reagents. The hydroquinine sublimed from uva ursi will give characteristic rod- and feather-like crystals which polarize light with a brilliant display of colors. The anthraquinones in rhubarb are readily sublimable and give the characteristic red reaction with alkalis. Micro-sublimation may be carried out as described early in the text.

It is also often expedient, as a check, to extract the powder with a suitable solvent and test the filtrate with such alkaloidal reagents as Mayer's or Wagner's, or for tannins with the various iron salt solutions. In certain cases the solvent may be evaporated and specific alkaloidal and other tests performed upon the residue. Among other special tests might be mentioned the potassium hydroxide test for conium, the vari-

ous anthraquinone tests, the alcoholic-sulfuric acid test or the boric acid test for curcuma, the Grahe tests for cinchonas, the sclererythrin test for ergot and many others.

Mixtures.—The identification of the individual constituents in a mixture of powders is more difficult than the identification of a pure simple powder. The key will be found useful in this work, but discrepancies are bound to arise (such as the admixture of a starch with a non-starchy drug) and must be taken into consideration.

Adulteration.—Adulterated samples are to be treated as mixtures. Common adulteration of individual drugs has been discussed in the various monographs throughout the text and the analyst should note these carefully. Many of the substances used as adulterants are listed in the key. The quality of drugs is another matter and depends upon the quantity of active constituent present. This is determined by special methods, such as solvent extraction, alkaloidal and glucosidal assay, etc. In connection with the subject of adulteration these methods serve to detect admixture with exhausted powders of the same drug which cannot be detected microscopically.

In the study and identification of powdered drugs the care of reagents and the employment of careful technique cannot be too strongly urged. Reagents, slides and other apparatus must be scrupulously clean. Conclusions should not be formed hurriedly and in the course of an examination several similar mounts should be made as checks upon one another. The successful micro-analysis of powdered drugs depends more upon the personal care and observation of the analyst than upon any other factor.

KEY FOR THE IDENTIFICATION OF POWDERS

Lignified tissue present.

I. STARCH PRESENT
  A. Calcium Oxalate Present
    a. In rosette aggregates.
      1. Fibers and stone cells present.
        (*a*) [illegible]

          β Powders dark brown.
            (1) Tracheæ present
              Rosettes up to 95 microns. Bast characteristic . . . Tonga
            (2) Tracheæ absent
              Stone cells up to 125 microns . . . Juglans
        (*b*) Crystal fibers absent.
          α [illegible]

[illegible]sclepias
[illegible]rydalis
[illegible]Manaca

Rumex (*crispus*)

Lignified tissue present.—(*Continued*).

I. Starch Present.

β Tracheæ absent.
(1) Fibers strongly lignified.
Bast numerous. Calcium oxalate mostly in prisms.................................Myrica
Bast few. Calcium oxalate mostly in rosettes..... ....Viburnum Prunifolium
Stone cells few. No prisms.. .....Viburnum Opulus
(2) Fibers non-lignified.
Stone cells containing prisms....... ......Cornus
Stone cells up to 190 microns .. . ...Condurango

2. Fibers present. Stone cells absent.
(*a*) Tracheæ present.
α Starch abundant.
Thick-walled fibers in groups..... .... Althea
Resin cells present .... Ipomea
Bast long and narrow. Slightly lignified.......Stillingia
Fibers few, thin-walled. .. .. Rumex (*obtusifolius*)
β Starch grains few.
Simple hairs up to 900 microns .. ..Damiana
Glandular and non-glandular hairs present ..Eriodictyon
(*b*) Tracheæ absent.
Bast strongly lignified, up to 1 mm.......Cotton Root Bark
Crystal fibers present...................... .Frangula
Bast thick-walled............... ... .Rubus

3. Stone cells present. Fibers absent.
Stone cells numerous, 40 to 90 microns..... . .. .. Canella
Stone cells 50 to 300 microns ... . Pomegranate Bark
Stone cells few. Tannin masses...... ... . Nutgall
Tracheæ present. Lignified hypodermal cells . ... Aralia

4. Fibers and stone cells absent.
(*a*) Tracheæ present.
Starch numerous .. .. Podophyllum
Tannin masses. Large rosettes.. .... Geranium
Rosettes up to 150 microns. Red with KOH . . Rhubarb
Resin cells present . ... Jalap
Characteristic glandular hairs. (Odor characteristic).. . . .. Chenopodium
(*b*) Tracheæ absent.
Secretion cells. Lignified cork.. ... .Euonymus

b. In prisms.
1. Fibers and stone cells present.
(*a*) Crystal fibers present.
α Powders light brown to olive brown.
(1) Rosettes also present — Sagrada

100 microns. . ...
(2) *No rosettes present.* .. *Cocillana*
Stone cells up to 150 microns ... Cascara Amarga
Bast groups numerous.. . ...Quillaja
Prisms 35 to 200 microns . ...Juglans
β Powder dark brown.
Stone cells up to 125 microns . ...

Lignified tissue present.—(*Continued*).

I. STARCH PRESENT.

- (*b*) Crystal fibers absent.
  - α Tracheæ present.
    - Fiber tracheids present . . Gelsemium
  - β Tracheæ absent.
    - (1) Fibers strongly lignified.
      - Bast numerous. Calcium oxalate mostly in prisms Myrica
      - Bast few Calcium oxalate mostly in rosettes Viburnum Prunifolium
    - (2) Fibers non-lignified, or slightly lignified
      - Stone cells containing prisms Cornus
      - Stone cells up to 190 microns Condurango
      - Lignified cork cells, few Northern Xanthoxylum
      - Lignified cork cells, numerous Southern Xanthoxylum

2. Fibers present. Stone cells absent
   - (*a*) Crystal fibers present
     - α Tracheæ present
       - (1) Starch abundant
         - Fibers numerous Cork present Spanish Glycyrrhiza
         - Fibers numerous Cork absent Russian Glycyrrhiza
       - (2) Starch grains few
         - Non-glandular hairs up to 600 microns . Galega
         - Entirely lignified Crystal fibers few Jamaica Quassia
         - Entirely lignified Crystals few Surinam Quassia
     - β Tracheæ absent.
       - Crystal fibers short Bast thin-walled . . Elm
   - (*b*) Crystal fibers absent.
     - α Fibers numerous.
       - Calcium oxalate mostly in rosettes Ipomea
       - Non-lignified wavy bast Krameria
     - β Fibers few.
       - Fibers only slightly lignified Calamus
       - Starch very small, 1 to 4 microns Cardamom Seed
       - Resin cells Prisms up to 350 microns Iris Versicolor
       - Simple hairs up to 900 microns Damiana
3. Stone cells present. Fibers absent
   - Stone cells few. Tannin masses Nutgall
   - Stone cells 50 to 300 microns Pomegranate Bark
   - Starch up to 85 microns Prisms in stone cells Calumba
4. Fibers and stone cells absent
   - (*a*) Tracheæ present
     - Prisms up to 500 microns Starch characteristic . Orris
   - (*b*) Tracheæ absent
     - Prisms up to 25 microns Resin masses White Pine

c. In raphides.

- (*a*) Fibers present.
  - α Stone cells present
    - (1) Tracheæ present
      - Raphides 50 to 135 microns . . . Hydrangea
    - (2) Tracheæ absent
      - Bast 0 3 to 1 5 mm Odor characteristic.
        - With cork Saigon Cinnamon
        - Without cork . . Ceylon Cinnamon

Lignified tissue present.—(*Continued*).

I. Starch Present.

β Stone cells absent.

(1) Cork present.

(i) Raphides often over 50 microns

Slightly lignified fibers... ......Veratrum Viride

(ii) Raphides less than 50 microns

Tracheids present..... ... .Ipecac

Fibers long.... .. .. Phytolacca

[illegible]

(2) [illegible]

[illegible] Aletris

Fibers and raphides few. ....Dioscorea

(ii) Fibers thin-walled.

Raphides up to 15 microns... .. . Sarsaparilla

Raphides up to 70 microns . ..... Cypripedium

(*b*) Fibers absent.

α Raphides up to 60 microns

Lignified endodermal cells......... ..Convallaria Root

Stomata *present*.... .. .. .Mitchella

β Raphides up to 225 microns

Mostly parenchyma ....Trillium

d. In sphenoidal microcrystals.

1. Tracheæ present.

(*a*) Fibers present.

[illegible] .. ... .Dulcamara

" [illegible] .. .Belladonna Root

" [illegible] . .... Calumba

(*b*) Fibers absent.

Seed-coat tissue present ... . Solanum

Characteristic glandular hairs .. .. Chenopodium

2. Tracheæ absent.

Bast 0.30 to 1.35 mm. .. .. Cinchona

B. Calcium Oxalate Absent.

a Fibers and stone cells present.

1. Tracheæ present.

(*a*) Stone cells numerous.

Odor slight Stone cells in groups.... . . Pareira

Odor characteristic. Palisade stone cells. . Cubeb

Cystoliths present. ... . Ruellia

(*b*) Stone cells few

Characteristic starch . . . . .Apocynum

2. Tracheæ absent.

Few short fibers .. . . Chionanthus

b. Fibers present. Stone cells absent.

1. Cork cells present.

(*a*) Odor aromatic.

α Hairs present.

Numerous thick-walled fibers . .. Euphorbia Pilulifera

Bast fibers few . . . ... Zedoary

β Hairs absent.

Characteristic beaked starch . . Ginger

Fragments of oil canals . . Angelica Root

Characteristic bast up to 400 microns . . . Sassafras

Valeric acid odor . .. Valerian

(*b*) Odor distinctive

Starch 2 to 15 microns. Yellow powder...... .Hydrastis

Lignified tissue present.—(*Continued*).

I. STARCH PRESENT.

(*c*) Nearly odorless	
Starch mostly simple	Caulophyllum
Starch 2- to 4-compound	Baptisia
2. Cork cells absent	
(*a*) Hairs present.	
Starch numerous up to 7 microns	Coptis
Starch grains few 7 to 20 microns	Scoparius
(*b*) Hairs absent.	
α Resin cells (or resin) present	
Starch compound up to 45 microns	Kava
Starch simple up to 9 microns	Leptandra
β Resin cells (or resin) absent	
(1) Odor slight	
Colors saliva yellow	Berberis
Starch 3 to 15 microns	Cimicifuga
Fibers few and non-lignified	Spigelia
(2) Odor distinct	
Odor camphoraceous or terebinthinate	Serpentaria
c. Stone cells present. Fibers absent	
Tabular stone cells, 100 to 400 microns	Aconite
Characteristic beaker cells. Starch very small	Black Pepper
Odor characteristic*	Allspice
d. Fibers and stone cells absent.	
1. Hairs present.	
Starch grains few. Oval tenacle heads, 100 to 200 microns	Drosera
Slightly lignified non-glandular hairs	Strophanthus
2. Hairs absent	
(*a*) Tracheæ few.	
Red with alcoholic sulfuric acid	Curcuma
Characteristic starch grains	Colchicum Corm
Few beaked starch grains	Colchicum Seed
Latex cells. Starch characteristic	Sanguinaria
Odor characteristic. Starch blue with iodine	Nutmeg
Odor characteristic. Starch red with iodine	Mace
(*b*) Tracheæ frequent	
α Cork present.	
Tracheæ up to 250 microns wide	Bryonia
β Cork absent	
Odor characteristic	Asarum
Characteristic granular substance present	Sumbul
Characteristic scalariform tracheæ	Aspidium

II. STARCH ABSENT

A. [illegible]

[illegible]	Pyrethrum Flowers
	Hyoscyamus
[illegible]	Santonica
[illegible] hairs up to [illegible] on[illegible]	Brayera
Large [illegible] pulin)	Humulus
[illegible]	Althea Leaves

* The presence of [illegible] rosettes indicate admixture with Allspice stems.

Lignified tissue present.—(*Continued*).

II. Starch Absent.

(c) Pollen absent.
Glandular hairs few........................Stramonium
Hairs up to 1 mm. Rosettes to 25 microns..Mallow Leaves
Twisted non-glandular hairs............ .... Eriodictyon
Cystoliths present in hairs.... ....Cannabis

2. Only non-glandular hairs present.
(a) Pollen grains numerous.
Chromoplasts present....................... ....*Calendula*
Mechanical elements numerous............. .Centaurium
(b) Pollen grains few.
Stem tissues numerous ....Passiflora
(c) Pollen absent.
α Crystal fibers present.
Thick papillose hairs. ....Senna
Hairs characteristic........ .... Castanea
β Crystal fibers absent.
Hairs few.......................... .... Buchu
...Anise
........Tea
.Damiana

3. . calcium oxalate. . . Grindelia
. Matricaria

4. Hairs absent.
(a) Calcium oxalate rosettes in aleurone grains.*
α Rosettes, 1 to 5 microns
Wavy-walled epidermal cells .... Caraway
Oil tubes, 100 to 200 microns wide . ... .Fennel
β Rosettes, 2 to 10 microns
..Celery Fruit
...Coriander
Angelica Fruit
.. .. .Conium
(b) Pollen present.
Pollen grains tetrahedral†. ... .*Clove*
(c) Pollen absent.
α Odor characteristic.
Bast slightly lignified ... . Eucalyptus
β Odor slight.
Epidermal tissues characteristic . . Chimaphila
Red with alkalis. Stone cells characteristic .... Rhamnus Cathartica

b. In prisms.
1. Glandular and non-glandular hairs present. .Melilotus
Crystal fibers present . . . .*Hyoscyamus*
Fibers up to 1 mm. . . . .. Brayera
Hairs up to 1 mm. Crystals mostly rosettes
2. Only non-glandular hairs present.
(a) Pollen present. Calendula
Chromoplasts present.. . . .. Centaurium
Mechanical elements numerous ... ...Trifolium
Non-glandular hairs characteristic. .. . . Galega
Thick-walled hairs up to 600 microns . . . .

* All members of this group possess a characteristic odor.
† Bast fibers present in Clove powder indicate the presence of stems Starch grains indicate the presence of clove fruits.

Lignified tissue present.—(*Continued*).

II, STARCH ABSENT.

(*b*) Pollen absent.
- Multicellular stellate hairs — Witch Hazel Leaves
- Red with alkalis.. — Senna
- Tannin (ammonio-ferric alum test) — Chestnut Leaves
- Characteristic jointed hairs — Matico

3 Hairs absent.

(*a*) Only xylem tissues present
- Ether extract orange-yellow, green fluorescence..... .. — Red Saunders
- Aqueous extract purple with alkalis — Hæmatoxylon
- Occasionally a few starch grains Bitter — Quassia

(*b*) Other tissues also present
- Yellow with NaOH T S — Bitter Orange Peel
- Characteristic sublimable hydroquinone — Uva Ursi
- Bast slightly lignified — Eucalyptus
- Stone cells to 145 microns — Juniper

c. In raphides.
- Raphides up to 1 mm. — Squill

d. In sphenoidal microcrystals.

1. Microcrystals only
   - *Pollen grains few* — Belladonna Leaf
   - Seed-coat fragments numerous — Solanum
   - Non-glandular hairs numerous — Tobacco
2. Rosettes numerous — Stramonium
3. Prisms present.
   - Non-glandular hairs 1- to 10-celled — Hyoscyamus
   - Characteristic jointed hairs — Matico

B. Calcium Oxalate Absent

a. Glandular and non-glandular hairs present

1. Pollen present.

(*a*) Odor mint-like and characteristic
- *α* Non-glandular hairs 1- to 8-celled
  - *Crystals in glandular hairs* — Peppermint
  - No crystals in glandular hairs — Spearmint
- *β* Non-glandular hairs not over 5-celled
  - Non-glandular hairs, 1 to 5 cells — Catnep
  - Non-glandular hairs, 2 to 3 cells — Pennyroyal

(*b*) Odor not mint-like
- *α* Pollen grains spiny.
  - Non-glandular hairs, 3 kinds — Arnica
  - Corolla tissues numerous — Eupatorium
  - Non-glandular hairs twisted — Horehound
  - Non-porous thin-walled fibers — Tansy
- *β* Pollen grains smooth
  - Odor slight . — Scutellaria
  - Odor characteristic — Thyme

2. Pollen grains absent.

(1) Greenish powders
- Non-glandular hairs unniseriate — Digitalis
- Non-glandular hairs branching — Mullein Leaves
- Non-glandular hairs parallel with leaf surface — Sage

(2) Reddish-brown powder.
- Small stone cells of endocarp . — Rhus Glabra

b. Only non-glandular hairs present

1. Pollen present.
   - Non-glandular hairs occasional . — Lobelia
   - Aqueous solution golden-yellow .... — Chelidonium

Lignified tissue present.—(*Continued*).

II. Starch Absent.

2. Pollen grains few.
   - Simple thick-walled hairs up to 2.5 mm............. Pulsatilla
   - Twisted multicellular hairs..................... Senecio
   - Long unicellular hairs .... Scoparius
3. Pollen absent.
   - [illegible]

c. Only glandular hairs present.
   - Oval tentacle heads characteristic.. .... Drosera

d. Hairs absent.

1. [illegible]

2. Fibers present. Stone cells absent.
   - (*a*) Pollen present.
     - Tracheæ numerous.............. Chirata
   - (*b*) Pollen absent.
     - α [illegible] ..Adonis
     - [illegible] . Thuja
     - β [illegible] Senega
     - [illegible] ...Inula
     - [illegible] .Taraxacum
     - [illegible] .Lappa
     - [illegible] .Triticum

3 Stone cells present. Fibers absent.
   - (*a*) Odor characteristic.
     - α Oily mounts. ... Linseed
       - Numerous oil globules ... Capsicum
       - Wavy-walled stone cells ... Coffee
       - Stone cells up to 1 mm.... ....
     - β Mucilaginous mount. ... Fenugreek
       - Stone cells polygonal ......
   - (*b*) Odor slight (when dry). ..*Pepo*
     - Stone cells uniformly thickened ... Black Mustard
     - [illegible] White *Mustard*
     - [illegible] .Colocynth
     - [illegible] t shells, olive pits, etc.

4. Stone cells and fibers absent.
   - (*a*) Aleurone grains present. ... Delphinium
     - Seed-coat cells with beaded walls. ... Cocculus
     - Aleurone grains up to 50 microns ... Mustard Flour
     - Aleurone grains alone present . .
   - (*b*) Aleurone grains absent. ... Gentian
     - Tracheæ scalariform and reticulate . . . . .

* Stone cells indicate the presence of seeds

Lignified tissue absent.

I. Vegetable Tissue Present.

A. Powders Reddish, Brownish or Yellowish

a. Unaltered starch grains present.

Oil globules numerous. Odor characteristic	Cacao
Starch grains, 10 to 60 microns	Galanga

b. Altered starch grains present

Gold chloride test characteristic	Guarana
Parenchyma with brownish walls	Kola

c. Starch grains few.

Non-porous bast fibers numerous	Mezereum
Green with ferric chloride	*Gambir*

d. No starch present.

1. *Consisting of hairs only*

Large glandular hairs	Lupulin
Glandular and non-glandular hairs	Kamala
Hairs with short, recurved, pointed protuberances	Mucuna

2. Consisting principally of spores

Characteristic spores; tetrahedral, 25 to 40 microns	Lycopodium
Spores about 7 microns	Ustilago

3. *Consisting principally of pollen grains*

Characteristic winged pollen grains	Pollen of Pine species

4. Consisting principally of parenchyma *or mycelial tissue*

Characteristic sclererythrin test		Ergot
Calcium oxalate prisms, 10 to 40 microns	Mycelia	Agaric
Epidermal tissue and pseudo-parenchyma		Fucus

B. Whitish Powders.

Polygonal starch grains, 10 to 35 microns	*Corn meal*
Starch grains, 5 to 40 microns	Wheat flour
Thick-walled hairs with narrow lumen	Wheat middlings
Starch grains, 20 to 60 microns	Rye flour
Thick-walled hairs with large lumen	Rye middlings
Starch, 5 to 25 microns	Barley flour
Sclerenchyma fibers with brown contents	Buckwheat flour
Hairs broader in the middle	Oatmeal

II. Vegetable Tissue Absent

A. *Only Unaltered Starch Grains Present*

a. Ovoid grains mostly simple.

Excentric circular hilum	Potato starch
Excentric fissured hilum	Maranta starch

b Polygonal grains.

Starch grains, 10 to 35 microns	Corn starch
Starch grains, 2 to 10 microns	*Rice starch*

c. *Lenticular grains*

Starch grains, 5 to 25 microns	Barley starch
Starch grains, 5 to 40 microns	Wheat starch
Starch grains, 20 to 60 microns	Rye starch

d. Reniform grains	Leguminous starches
e. Characteristic grains	Other starches

B. Altered Starch Grains Present.

Becoming pasty on addition of cold water	Dextrin
Becoming pasty with hot water	Sago
Disintegrates with water	Sago (Imitation)

C. Starch Grains and Mucilage Present

Swells in water	Tragacanth

Lignified tissue absent.—(*Continued*).

II. VEGETABLE TISSUE ABSENT.

D. No Starch Present.

a. White Powders.

1. Soluble in water.

[illegible]

. Acacia

Sucrose

Lactose

2. Insoluble in water.

(*a*) Soapy feel.

Broken crystals .... Talc

(*b*) Soluble in acetic acid.

α [illegible]

Rhombic crystals or irregular fragments .... Barium Carbonate

β Without effervescence.

Rounded masses .... Heavy Magnesia

Very light .... Light Magnesia

(*c*) Insoluble in acetic acid (but soluble in nitric acid).

Tetragonal or cubical crystals .... *Precipitated Calcium Phosphate*

Acicular crystals .... *Calcium Sulfate*

Rhombic prisms or crystals of various sizes .... Barium Sulfate

Irregular fragments .... Terra Alba

(*d*) Consisting of diatoms .... Infusorial Earth

b. Yellow Powders.

1. Giving off *odor* of sulfur dioxide on heating.

Rounded *masses in chains* .... Washed Sulfur

Rounded masses in *irregular groups* .... *Precipitated Sulfur*

2. No odor of sulfur dioxide on heating.

(*a*) Nearly colorless in glycerin mount.

Transparent irregular masses .... Mastic

(*b*) Yellowish in glycerin mount.

α Containing oil globules.

Irregular masses .... Scammony

β Transparent or translucent.

Soluble in cold alcohol. Green with copper acetate. .Rosin

Insoluble in cold alcohol. No green color with copper acetate .... Sandarac

Reddish with alkalis .... Aloe (Cape)

γ More opaque.

Light or grayish particles .... Ammoniac

Yellowish particles .... Gamboge

c Brownish powders.

1. With occasional cellular tissue* .... *Opium*

2. Without cellular tissue.

(*a*) Possessing oil.

Grayish fragments .... Asafetida

Yellowish or yellowish brown fragments .... *Myrrh*

* Opium *may* contain tissues from the poppy capsule, or from the leaves of *Rumex* species in which it is *occasionally* packed. If a diluent has been added its *microscopic* characteristics will also be evident.

Lignified tissue absent.—*(Continued)*

II. VEGETABLE TISSUE ABSENT.

(*b*) Without oil.

α Remaining opaque in glycerin

- Red with alkalis ... Aloe (Socotrine)
- Characteristic odor, and sublimate ... Benzoin
- Grayish opaque fragments ... Elaterium
- Brownish angular fragments ... Lactucarium

β More or less translucent in glycerin

- Yellowish brown. Red with alkalis. Finally green with HNO_3 ... Aloe (Cape)
- Dark brown. Red with alkalis. Red with HNO_3. ... Aloe (Curaçao)
- Yellowish brown. Red with alkalis. Yellow with HNO_3 ... Aloe (Socotrine)
- Acicular crystals. Green with ferric chloride ... Gambir
- With rhombohedral crystals ... Catechu
- Fragments translucent, deep red ... Kino
- Microcrystalline. Red with alkalis ... Chrysarobin

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